University of Alberta

Characterization and Assessment of Human and Environmental Health Risks Associated with Urban and Peri-Urban Livestock Keeping in Kaduna Metropolis, Nigeria

by

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Abstract

The present research focuses on the assessment and characterization of potential health risks associated with keeping of livestock in the Kaduna metropolis of Nigeria. Specifically, the study uses knowledge of previous research to determine the influence of socioeconomic factors on household choice behaviour and the application of psychometric paradigms to assess risk perception and attitudes among livestock keeping households located in three metropolitan locations (rural, peri-urban and urban). The study findings are based on primary data generated from 309 households randomly selected from purposively selected metropolitan locations. The result shows that livestock keeping being traditionally an activity associated with rural settings has transited from these boundaries to peri-urban and urban areas. In addition, the results reveal that despite the identified familiarity with associated potential health and environmental concerns, the economic benefits derived from such activity tend to override the perceived risks. The exploratory factor analysis revealed nine underlying factors (severity, environment, control, knowledge, catastrophic potential; awareness, involuntariness, experience and zoonotic effects) of perceived human and environmental health concerns associated with livestock keeping in the study location. In the same vein, two underlying factors (economic/social versus cultural/nutritional benefits and livelihood strategy versus food security) each were identified for both perceived benefits and importance of livestock keeping to households in the study location respectively.

Dedication

This Thesis is dedicated to the memory of my late Father

Pa J.M.A Ajayi

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TABLE OF CONTENTS

1.0 CHAPTER ONE: BACKGROUND OF THE STUDY 1

1.1 INTRODUCTION 1

1.2 DESCRIPTION AND OVERVIEW OF URBAN AND PERI-URBAN AGRICULTURE 2

1.3 ECONOMIC PROBLEM 3

1.4 RESEARCH OBJECTIVES 6

1.5 THESIS ORGANIZATION 7

2.0 CHAPTER TWO: REVIEW OF LITERATURE 8

2.1 INTRODUCTION 8

2.2 GLOBAL CLASSIFICATION OF LIVESTOCK PRODUCTION SYSTEMS 8

2.3 IMPACTS OF URBAN AND PERI-URBAN LIVESTOCK PRODUCTION (UPLP) 10

2.3.1 Role of Urban and Peri-urban Livestock Production UPLP in Household Food Security, Nutrition and Poverty Reduction 10

2.3.2 Role of Livestock Keeping and Environmental Management 11

2.3.3 Review of Earlier Studies on Socioeconomic Determinants of Urban Livestock Production Systems 14

2.3.4 Summary 22

2.4 CHANGING GLOBAL ENVIRONMENT AND EVOLVING LIVESTOCK PRODUCTION SYSTEMS ASSOCIATED WITH ZOONOTIC AND FOOD-BORNE DISEASES 22

2.4.1 Overview of Major Potential Human and Environmental Health Risks Associated with Urban and Peri-urban Livestock Keeping 25

2.4.2 Studies on Potential Health Risks Associated with Urban Livestock Keeping 29

2.5 DIMENSIONS IN RISK MANAGEMENT PROCESS AND RISK PERCEPTION STUDIES 31

2.5.1 Psychological and Cognitive Dimensions in Risk Perception 32

2.5.2 Approaches Used in Risk and Risk Perception Studies 34

2.5.3 Empirical Studies on Risk Perceptions and Attitudes 38

2.5.4 Willingness-to-Pay (WTP) Approach to Health Risk Reduction 40

2.6 CHAPTER SUMMARY 43

3.0 CHAPTER THREE: *THEORETICAL AND EMPIRICAL FRAMEWORKS* 51

3.1 INTRODUCTION 51

3.2 THEORETICAL FRAMEWORK 52

3.2.1 Theory of Decision Making 52

3.2.2 Utility Theory for Decision Making 53

3.2.3 Cognitive Psychology (Psychometric Paradigm) 57

3.3 EMPIRICAL FRAMEWORK ... 57
3.3.1 *Modeling socioeconomic determinants of household decision-making process and willingness-to-pay for health risk reductions* ... 58
3.3.2 *Choice of Socio-Demographic Variables Influencing Decision to Keep Livestock and Willingness-to-Pay for Health Risk Reductions* ... 59
3.3.3 *Choice of Variables for Attitudinal and Risk Perception Attributes* ... 60
3.4 CHAPTER SUMMARY ... 61

4.0 CHAPTER FOUR: *SURVEY DESIGN AND METHODOLOGY* ... 63

4.1 INTRODUCTION ... 63
4.2 DESCRIPTION OF STUDY AREA ... 63
4.2.1 *Demography* ... 66
4.2.2 *Geography* ... 67
4.2.3 *Overview of Livestock Keeping in Kaduna State* ... 67
4.3 DESIGN OF THE SURVEY INSTRUMENT ... 68
4.3.1 *Sampling Procedure and Sample Size Selection* ... 68
4.3.2 *Survey Techniques* ... 70
4.3.3 *Survey Administration* ... 70
4.3.5 *Sampling Methods* ... 71
4.4 CONTINGENT VALUATION TECHNIQUES FOR THE WILLINGNESS-TO-PAY (WTP) QUESTIONS ... 72
4.5 CHAPTER SUMMARY ... 73

5.0 CHAPTER FIVE: *ANALYSIS OF THE SURVEY DATA SET* ... 76

5.1 INTRODUCTION ... 76
5.2 DESCRIPTIVE ANALYSIS OF DATA SET ... 77
5.2.1 *Gender* ... 80
5.2.2 *Age category* ... 81
5.2.3 *Marital Status* ... 83
5.2.4 *Educational Level* ... 83
5.2.5 *Number of Children* ... 85
5.2.6 *Household Size* ... 86
5.2.7 *Household Income Category* ... 87
5.2.8 *Employment Status* ... 88
5.2.9 *Predominant Livestock Keeping System and Type of Livestock Kept* ... 90
5.3 DIFFERENCES IN RISK PREFERENCES (PERCEPTIONS) AND ATTITUDES ... 92
5.3.1 *Familiarity of respondents with health risks associated with keeping of livestock* ... 92

5.3.2 Perceived Potential Benefits Derived from Livestock Keeping *96*
5.4 COMPARISONS OF MEANS OF AVERAGE OVERALL PERCEIVED RISKS ACROSS SELECTED SOCIOECONOMIC VARIABLES **106**
5.5 FACTOR ANALYSIS OVERVIEW **115**
5.5.1 Principal Components Analysis (PCA) *116*
5.5.2 Discussion of PCA Results *120*
5.6 RESPONDENTS' VIEWS ON HEALTH RISK REDUCTION PREFERENCES AND ATTITUDES **127**
5.7 CHAPTER SUMMARY **131**

6.0 CHAPTER SIX: *MODEL SPECIFICATION, ESTIMATION AND RESULTS* **133**

6.1 INTRODUCTION **133**
6.2 DEFINITION OF MODEL VARIABLES **133**
6.2.1 Description of Dependent Variables *133*
6.2.2 Description of Independent Variables *135*
6.3 ESTIMATION PROCEDURE **138**
6.3.1 Model Selection *139*
6.3.2 Model Specification *140*
6.4 DISCUSSION OF RESULTS **142**
6.4.1 Socio-demographic Determinants of Household Decision to Keep Livestock *143*
6.4.2 Determinants of Willingness-To-Pay (WTP) for Health Risk Reduction *144*
6.4.3 Determinants of Household Attitudes and Perception of Risks Associated with Livestock Keeping *147*
6.5 DISCUSSION ON ESTIMATED COEFFICIENTS OF EXPLANATORY VARIABLES **148**
6.5.1 Estimated Results and Effects of Socio-Demographic Factors on Household Decision to Keep Livestock *149*
6.5.2 Estimated Results and Effects of Socio-economic and Risk Characteristics on the Willingness-To-Pay for Health Risk Reduction Associated with Livestock Keeping *150*
6.5.3 Estimated Results and Effects on Overall Perceived Risks Associated with Livestock Keeping *151*
6.6 CHAPTER SUMMARY **152**

7.0 CHAPTER SEVEN: SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS **154**

7.1 INTRODUCTION **154**
7.2 SUMMARY AND CONCLUSIONS OF THE STUDY **154**
7.3 HEALTH AND PUBLIC POLICY IMPLICATIONS OF FINDINGS **157**
7.4 POSSIBLE LIMITATIONS AND FUTURE RESEARCH INITIATIVES **158**

REFERENCE LIST 161

APPENDICES 171

A1: APPENDIX TO CHAPTER FIVE 171
A2: APPENDIX TO CHAPTER SIX 174
A3: SAMPLE OF INFORMATION SHEET FOR PARTICIPANTS 186
A4: SAMPLE OF SURVEY QUESTIONNAIRE 188

LIST OF TABLES

Table 2-1: Major Agricultural Activities and their Associated Health Risks Categories........................ 28
Table 2-2: Risk Rating Scales 42
Table 2-3: Previous Studies on Urban Agriculture and Some Socio-Economic Determinants of Urban Livestock Keeping in Other Regions 45
Table 4-1: Local Government Areas (LGA's) in Kaduna State 66
Table 4-2: Selection of the Primary Sampling Unit (PSU) from each Local Government Area............ 69
Table 4-1: Sample of Studies that used Survey Questionnaire to Study Urban Agriculture.................. 74
Table 5-1: Comparison of Sample Survey Characteristics versus Census-based Demographic Data of Nigeria and Canada Population 78
Table 5-2: Percentage Distribution of Selected Households by Location and Enumeration Area 79
Table 5-3: Summary Statistics of Selected Socioeconomic and Demographic Characteristics of Respondents in the Data Set 80
Table 5-4: Frequency Distribution of Households Keeping Livestock by Location and Gender 81
Table 5-5: Frequency Distribution of Households Keeping Livestock by Age Categories of Respondents.. 82
Table 5-6: Frequency Distribution of Respondents by Marital Status 83
Table 5-7: Frequency Distribution of Households by Respondents' Educational Level........................ 85
Table 5-8: Frequency Distribution of Respondent's Household Location by Number of Children living in the Household.. 86
Table 5-9: Frequency Distribution of Household Size by Location and Livestock Keeping................. 87
Table 5-10: Frequency Distribution of Households keeping Livestock by Income Category 88
Table 5-11: Frequency Distribution of Respondents by Employment Status 89
Table 5-12: Frequency Distribution of Types of Livestock Kept by Household Location 91
Table 5-13: Familiarity of Health Risk Concerns Associated with Keeping Livestock in Cities 94
Table 5-14: Familiarity of Health Risk Concerns Associated with Keeping Livestock by Gender 94
Table 5-15: Percentage Frequency Distribution of Respondents' Who Agreed/Disagreed on the Statement of Keeping Livestock to be Risky.. 95
Table 5-16: Educational Level of Respondents and Perceived Environmental Benefit Derived From Keeping Livestock in Different Household Locations 98

Table 5 -17: Percentage Distribution of Livestock Importance in Providing Food Security to Respondents by Household Locations 99
Table 5 -18: Percentage Distribution of Livestock Importance in Providing Cash Income to Respondents by Household Locations 99
Table 5-19: Percentage Distribution of Livestock Importance in Providing Subsistence Support to Respondent's Household by Location 99
Table 5-20: Percentage Distribution of Livestock Importance in Providing Animal Food Source to Respondents by Household Locations 100
Table 5-21: Percentage Distribution of Livestock Importance in Providing Employment to Respondents by Household Locations 100
Table 5-22: Comparison of Means across Households Keeping Livestock 107
Table 5-23: Test of Homogeneity of Variances 107
Table 5-24: ANOVA Table Showing Average Overall Perceived Risk across Household Keeping Livestock 107
Table 5-25: Robust Tests of Equality of Means 108
Table 5-26: Comparison of Means across Gender 108
Table 5-27: Test of Homogeneity of Variances 108
Table 5-28: ANOVA Table Showing Average Overall Perceived Risk across Gender 109
Table 5-29: Robust Tests of Equality of Means 109
Table 5-30: Comparison of Means across Respondent Household Location 109
Table 5-31: Test of Homogeneity of Variances 109
Table 5-32: ANOVA Table Showing Average Overall Perceived Risk across Household Location .. 110
Table 5-33: Robust Tests of Equality of Means 110
Table 5-34: Comparison of Means across Respondent's Household Size 111
Table 5-35: Test of Homogeneity of Variances 111
Table 5-36: ANOVA Table Showing Average Overall Perceived Risk across Household Size 111
Table 5-37: Robust Tests of Equality of Means 111
Table 5-38: Comparison of Means across Respondent's Marital Status 114
Table 5-39: Test of Homogeneity of Variances 114
Table 5-40: ANOVA Table Showing Average Overall Perceived Risk across Marital Status 114
Table 5-41: Robust Tests of Equality of Means 114
Table 5-42: Comparisons of Means across Educational Status of Respondents 115
Table 5-43: Test of Homogeneity of Variances 115

Table 5-44: ANOVA Table Showing Average Overall Perceived Risk across Educational Status..... 115
Table 5-45: Robust Tests of Equality of Means 115
Table 5-46: Perceived Benefits versus Perceived Risk Characteristic Statements..... 120
Table 5-47: Description of Overall Risk, General Attitudinal Factors and Perceived Risk Attributes 121
Table 5-48: Principal Component Analysis and Factor Loadings across Nine Perceived Risk Attributes 124
Table 5-49: Total Variance Explained of Retained Items, Rotated Factor Loadings and Eigenvalues for Nine Perceived Risk Attribute Factors..... 126
Table 5-50: Reliability Statistics 126
Table 5-51: Bartlett and KMO Tests 126
Table 5-52: Principal Component Analysis and Factor Loadings of Potential Benefits Derived from Keeping Livestock..... 127
Table 5-53: Principal Component Analysis and Factor Loadings of Perceived Importance of Keeping Livestock..... 127
Table 5-54: Frequency Distribution of Willingness-To-Pay for Health Risk Reductions by Respective Socioeconomic Variables with Statistically Significant Coefficients..... 130
Table 5-55: Cross Tabulations of Respondents' Decision to Keep Livestock in their Households and Socio-Demographic Characteristics with Statistically Significant Coefficients..... 131
Table 6-1: Operational Definitions of Dependent and Independent Variables 138
Table 6-2: Different Variations of the Final Model Specification 143
Table 6-3: Logistic Regression Estimates of Socio-Demographic Determinants of Households' Decision to Keep Livestock..... 145
Table 6-4: Logistic Regression Estimates of the Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping 146
Table 6-5: Logistic Regression Estimates of Respondents' Overall Perceived Risk and Attitudes toward Livestock Keeping..... 148

LIST OF FIGURES AND MAPS

Figure 2-1: Risk Perception and Management Process 32
Figure 3-1: Conceptual Model of Household's Decision-Making Process in Keeping Livestock 62
Figure 4-1: Map of Nigeria Showing Major Cities 64
Figure 4-2: Map of Nigerian States by Population Density 65
Figure 5-1: Distribution of Households Surveyed by Metropolitan Location 79
Figure 5-2: Livestock Keeping by Respondent's Age Category 82
Figure 5-3: Percentage Frequency Distribution of Respondents by Income Category and Household Location 88
Figure 5-4: Respondent's Household Keeping Livestock by Employment Status 89
Figure 5-5: Types of Livestock Kept by Respondents in Different Household Location 91
Figure 5-6: Familiarity of Health Risk Concerns by Household Location 95
Figure 5-7: Familiarity of Health Risk Concerns by Gender 96
Figure 5-8: Percentage distribution of respondents' view on benefit derived as additional cash income from livestock keeping 102
Figure 5-9: Percentage distribution of respondents' view on benefit derived from the sale of animal manure for keeping livestock 102
Figure 5-10: Percentage distribution of respondents' view on benefit derived in providing employment for keeping livestock 103
Figure 5-11: Percentage distribution of respondents' view of deriving food security benefits 103
Figure 5-12: Percentage distribution of respondents' view on cultural and social benefits derived from keeping livestock 104
Figure 5-13: Percentage distribution of respondents' view on benefit derived from household waste management 104
Figure 5-14: Percentage distribution of respondents' view of deriving subsistence support benefit 105
Figure 5-15: Percentage distribution of respondents' view on overall benefits derived from livestock keeping 105
Figure 5-16: Percentage Distribution of Overall Benefits Derived from Livestock Keeping 106

LIST OF ABBREVIATIONS AND ACRONYMS

AAFRD	Alberta Agriculture, Food and Rural Development
AHPI	Agro-environmental Hygienic Pressure Indicators
AI	Avian Influenza
ASF	African swine fever
BSE	Bovine Spongiform Encephalomyelitis
CCHF	Crimean-Congo haemorrhagic fever
CDC	Centers for Disease Control and Prevention
FA	Factor Analysis
FAO	Food and Agriculture Organization of the United Nations
IAR	Institute for Agricultural Research
IDRC	International Development Research Centre
IID	Independently and Identically Distributed
ILRI	International Livestock Research Institute
LGA	Local Government Area
LID	Livestock in Development
LIMDEP	Limited Dependent
NLPD	National Livestock Project Division
nvCJD	new variant Creutzfeldt - Jakob disease
PCA	Principal Component Analysis
RTG	Roof-Top Gardening
RVF	Rift Valley Fever
SPSS	Statistical Packages for Social Science
TSP	Time Series Processor
UA	Urban Agriculture
ULP	Urban Livestock Production
UPA	Urban and Peri-urban Agriculture
UPLP	Urban and Peri-urban Livestock Production
VPH	Veterinary Public Health
W H O	World Health Organization
WTP	Willingness-to-Pay

1.0 CHAPTER ONE: BACKGROUND OF THE STUDY

1.1 Introduction

Livestock are widely found in poor communities across the developing world. Livestock keeping has long been documented as one of the most important agricultural livelihoods practiced in Africa, especially in areas with water scarcity, including arid and semi-arid regions. It was estimated that two-thirds of resource-poor rural households keep some type of livestock (Livestock in Development 1999). The rapidly growing demand for livestock products worldwide has been attributed to increased human population pressure, growing incomes and urbanization (Delgado et al. 1999). In developing countries, however, the demand for food is estimated to grow by 50 percent over the next 20 years in order to sustain human population growth while demand for livestock products is expected to double during the same period (Steinfeld 2003). This forecast is expected to depend partly on the progress made in reducing poverty that has resulted in an increasing propensity of people to spend more disposable income on animal food products, particularly in urban areas.

In sub-Saharan Africa, however, urban and peri-urban crop and livestock production has been identified as an important resource for meeting food security challenges of rapidly growing cities, and the positive aspects of such production have been well documented in the literature. Central among the major issues arising from urban and peri-urban agriculture to the Food and Agricultural Organization's mandate in member countries have been to:

- provide adequate access to nutritious food for the growing urban populations of the developing world;
- efficiently integrate urban and peri-urban agriculture (UPA) with rural agriculture (which in general should not be substitutes for each other);
- develop land and water policies that account for agricultural production in the urban and peri-urban areas; and

- guide dynamic agricultural practices within and outside cities towards sustainability goals - economic, social and environmental (FAO 1997).

As a result of this, there is now a vast literature that addresses many of the issues confronting the sustainability of urban and peri-urban livelihoods (Aldington 1997; Tacoli 1998; Mougeot 1999; Briggs and Mwamfupe 2000; Lynch , Binns, and Olofin 2001).

1.2 Description and Overview of Urban and Peri-Urban Agriculture

Several studies have been carried out on urban and peri-urban agriculture (UPA) in which most authors defined UPA only in general terms, rarely using their study findings to refine the concept of UPA and relate it to development concepts. A working definition that can be used to describe urban agriculture (hereafter refer to as UA) is given by Rees (1997), who defined UA "as any activity associated with the growing of crops and some forms of livestock in or very near cities for local consumption, either by the producers themselves or by others when food is marketed". This definition is also in line with the one given by Mougeot (1999), who defined UA "as an industry located within (intra-urban) or on the fringe (peri-urban) of a town, an urban centre, a city or a metropolis which grows or raises, processes and distributes a diversity of food and non-food products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area". Other definitions of UA that can be applied in the same development context for the purpose of this study are those given below;

> *"UA has been defined as the production of crops and livestock by urban households for consumption and for the urban market. This type of economic activity is considered informal since most practitioners of it do not follow legal procedures in acquiring land"* (ENDA-ZW 1997).

Aldington (1997) definition of UA paraphrased as "farming and related activities that take place within the purview of urban authorities…(where urban authorities are) the panoply of laws and regulations regarding land use and tenure rights, use of water, the environment, etc, that have been established and operated by urban or municipal authorities". This definition further includes UA which also takes place within certain boundaries, which may extend quite far from an urban centre. While peri-urban agriculture takes place beyond this often geographically precise boundary its own outer boundary may be less well defined as noted by this definition. Mougeot (1994) earlier defined UA as the growth of food and non-food plant and tree crops and the raising of livestock both within (intra-) and on the fringe of (peri-) urban areas.

The contributions of urban and peri-urban crop and livestock production to urban food security, improved nutrition, poverty alleviation and local economic development have largely been acknowledged. In spite of the fact that UA is being recognized more and more as an important source of food and income generation in cities, adequate institutional frameworks that support farming at municipal and local levels are still believed to be lacking (IDRC 2004). At the institutional level, one of the contentious issues identified relating to UPA practices, is the potential health risks associated with it. It was argued that if UPA is not well managed and supported, it can result in human and environmental health risks. Although potential health risks connected to UPA have been highlighted, there is still little comprehensive understanding about how to reduce the identified health risks (ILRI-International Livestock Research Institute 2004).

1.3 Economic Problem

Despite laws and regulations prohibiting the practice of urban agriculture in some countries, urban and peri-urban livestock production systems have thrived and remain an integral part of towns and cities in many low-income countries like Nigeria because they fulfill important social and economic functions. Mougeot (1999) highlighted the effective contribution of UPA in low-income countries in reducing food insecurity by improving food intake of households and raising children's nutritional status. He also emphasized that the evidence from literature that overtly condemned UPA is minimal. Most opposition to UPA has tended to be from urban planners as evidenced in some developed countries like Canada and United States where livestock keeping within cities is discouraged. Also opposition has tended to come from public health and environmental circles rather than from agencies covering employment, community services and agriculture. But in spite of the beneficial effects of UPA, increased concentration of animals in urban and peri-urban areas to meet increased meat and milk demand raises a number of public and natural resource management challenges. Studies have shown that increased concentration of animals in areas of high human density may facilitate the transmission of zoonotic diseases such as tuberculosis, brucellosis, salmonellosis and echinococcosis between production units as well as between animals and human beings during husbandry, processing or consumption of livestock products (Lock and de Zeeuw 2000).

Over the years, this fact had been buttressed by findings from several studies carried out in some developing countries. One such study by Acha and Szyfres (1987) on intensive dairy production revealed that the highest incidences of bovine tuberculosis in milk sheds are found in larger cities where the bulk of the milk was destined for urban markets. This view was supported by Cosivi et al. (1998) who found that this was a common problem in most developing countries where there is inadequate veterinary supervision of livestock production. Evidence from other studies from major cities in Nigeria on echinococcus infections transmitted by domestic livestock and those conducted in other West African countries concluded that a greater number of animals infected with brucellosis in intensive production systems are found in flocks in urban and peri-urban areas rather than in traditional systems.

Studies conducted in developed countries especially in the U.S. identified the stress large-scale livestock production facilities have placed on the physical environment. This was also considered as a leading source of current public concern associated with livestock industrialization and spatial concentration of production (Abdalla et al. 1995; Hubbel and Welsh 1998; Sharp and Tucker 2005). Manure management and water quality impacts are some of the prominent environmental concerns identified as central issues in several studies of local resistance to livestock development.

Urban and peri-urban livestock production is often carried out in confined places, therefore manure disposal has become an important environmental as well as health issue for producers and also for neighbouring communities. Producers and processors are also coming under increasing pressure to restrict such economic activities by municipal authorities because of the odours, flies, noise and other nuisance contaminants from their operations. Odour from livestock operations has been considered to be more of a nuisance than a health risk to neighbours, which could have either psychological or physiological health effects. It therefore becomes difficult to evaluate odour and its health effects from livestock operations (Alberta Agriculture 2003).

Recent animal health emergencies have highlighted the vulnerability of the livestock sector to the impact of infectious diseases and the associated risks to human health (FAO/OIE 2004). Over the years, new veterinary public health concerns are being discovered and evolving epidemic diseases that pose high threats to humans have been found especially in developing countries. Waste from livestock farming and processing of livestock products is also thought to be a potential source of environmental degradation. Waterborne and food-borne pathogens are identified as some of the health risks that need to be given serious thought and have been confirmed to emanate from livestock production and processing systems.

In spite of these potential risks, many of which need to be properly addressed, urban and peri-urban livestock keeping still play important social and economic roles in developing countries that are beneficial to health and well-beings of the urban poor and these are highlighted below:

- Increase in urban food security and improved nutrition;
- Income generation and poverty alleviation;
- Waste recycling and improved sanitation;
- Meeting religious and cultural obligations (Thys et al. 2005).

There is need for a compromise, which would permit environmental protection and enhance health while at the same time maintaining viable small livestock producers and processors. There is also need to identify and understand this means of livelihood among different stakeholders and its various activities that could pose potential risk to human health and the environment. Bearing this in mind and to adequately address the economic problem stated above, the aim of this study is to examine the following research questions:

- What socioeconomic factors influence urban and peri-urban livestock keeping in the study area?
- What human and environmental health risks are associated with urban and peri-urban livestock keeping in the study area?
- What are the attitudes and perceptions of households towards potential health risks associated with urban and peri-urban livestock keeping?
- Are households willing to pay for reduction in some of these identified health concerns associated with keeping livestock close to human habitation?

1.4 Research Objectives

The assessment of risks (costs) and benefits usually takes a broad view of potential impact, which includes social, economic and ethical impacts as well as health and safety. Not only are human and environmental health risks important but also potential benefits associated with urban and peri-urban livestock keeping should be analyzed. The primary focus of this study is to try to assess the major human and environmental health risks associated with livestock keeping in Kaduna metropolis. This will provide recommendations that could form the basis for policy formulations and further research in addressing public health issues. In the course of the study, the following specific objectives will be addressed:

1. Determine socio-economic factors that influence livestock keeping in the study location;

2. Identify human and environmental health risks associated with urban and peri-urban livestock keeping in the study location;
3. Assess attitudes and perceptions of people towards health risks associated with keeping of livestock.
4. Determine the willingness-to-pay (WTP) for environmental intervention to reduce identified health risks resulting from livestock keeping activities in the metropolis.

1.5 Thesis Organization

The rest of this thesis is organized as follows. In chapter two, there is a review of previous studies on the contribution of UPA and its impact on human welfare and the environment. An extensive literature review was conducted to search for previous studies on urban and peri-urban livestock keeping and some identified human and environmental health risks. The changing global environment and its implications to evolving livestock production systems and associated public health concerns are highlighted. Also a review of the psychological and cognitive dimensions used in risk perception studies is briefly highlighted. In chapter three the conceptual and empirical approaches used in this study are highlighted. A very simple conceptual model of households' decision-making process in keeping livestock and their socio-demographic determinants of keeping livestock is developed. This model serves as the guide for the specification of the econometric models. A detailed survey methodology is presented in chapter four describing the study area and sampling techniques employed. The survey questions used to measure socio-demographic information and the WTP valuation techniques are described. An explicit discussion of the data set collected is presented in table, text and graphical forms in chapter five. The empirical model selection and its specification are dealt with accordingly in chapter six. This chapter consists of the estimation strategy and discussion of the results from the econometric analysis. A comprehensive summary of the study results and some conclusions are specified in chapter seven. Also, the limitations of the study were noted and directions for further research in this challenging area of work are suggested.

2.0 CHAPTER TWO: REVIEW OF LITERATURE

2.1 Introduction

Detailed background information is necessary before specifying an empirical model for this research. A review of literature is presented in this chapter to provide an analytical summary of related theories and references within the contextual framework of human choice behaviour and psychometric risk perception theory. A brief summary discussion of global livestock production systems and their role in achieving household food security, nutritional balance and poverty alleviation is presented. Highlights of various studies conducted on socioeconomic determinants that dictate the systems of livestock keeping adopted by urban and peri-urban households are also summarized and some of the salient points identified. These reviews also identify cultural, country and region specific factors that have influenced or sustained such production systems. Highlights of potential human and environmental health risks associated with urban livestock keeping are also addressed.

2.2 Global Classification of Livestock Production Systems

Sere and Steinfeld (1996) described four broad classes of global livestock production systems adopted from farming systems research. The four main types of livestock classification identified are:

- Grassland-based systems, based solely on grass fed livestock, in which more than 90 per cent of the dry matter (DM) fed to animals comes from rangelands, pastures or home-grown forages and in which annual average stocking rates are less than 10 livestock units (LU) per ha of agricultural land.
- Rain-fed mixed farming systems, in which more than 10 per cent of the dry matter fed to animals comes from crop by-product or more than 10 per cent of the total value of production comes from non-livestock farming activities. In these systems, more than 90 per cent of the value of non-livestock farm produce comes from rain-fed land use.

- Irrigated mixed farming systems. These are similar to the previous systems, but more than 90 per cent of the total value of non-livestock farm produce comes from irrigated land use.
- Landless livestock production systems are solely livestock-based with 10 per cent or less of the dry matter fed to animals coming from farm produce and in which stocking rates are above 10 livestock units per ha of agricultural land. These systems raise either monogastric (pig/poultry) or ruminant animals and may take an urban or peri-urban form.

Smith and Olaloku (1998) used this global classification in their study reported by IDRC, to classify urban and peri-urban livestock production systems into two sub-categories under the broad category of the landless livestock systems. They classified urban livestock production (ULP) systems into subsistence or commercial based on the primary purpose of production. In the subsistence production systems the primary purpose of production is identified to meet family needs, and this may involve few or no commercial exchanges. This system is similar to the urban system identified by Fall et al. (2002) in a study of the Senegalese livestock production systems. The urban families keep a few chickens and two or three sheep or goats for occasional consumption. Little or no investment is involved in such systems and the animals scavenge for a larger part of their feed requirement which is usually supplemented by household kitchen wastes (Smith and Olaloku 1998; Mfoukou et al. 2001; Fall et al 2002).

The commercial production system is also referred to as the intensive system, which involves (primarily) producing or raising animals for sale and sometimes with a secondary objective for home consumption. The operational scale of this system depends largely on the size of the enterprise which could be smallholder or large-scale levels. A survey of small ruminant livestock producing households conducted in three cities in Ghana identified the use of unpaid family labour as a distinguishing feature of the smallholder from the large-scale commercial livestock production units. The study also confirmed the use of family labour to contribute substantially to the labour requirement especially with flock size ranges from 1-15 per household (Baah 1994).

Staal and Shapiro (1994) described the smallholder urban and peri-urban commercially oriented dairy production enterprises common in and around many cities of Africa. This was highlighted as a major development story in sub-Saharan Africa that has been successfully sustained within most of these major cities. These units are located within or close to major cities and have herd sizes of about 10 cows usually kept under an intensive zero-grazing regime. Several studies have used this farming system approach to identify evolving urban livestock production systems practiced. The information gathered from such studies was further used in this present study to address major public health concerns and how these systems have contributed to human and environmental health risks.

2.3 Impacts of Urban and Peri-urban Livestock Production (UPLP)

The contributions of urban livestock production to overall development include income and employment generation, poverty alleviation, and improvement of human nutrition and health. The urban livestock production system is complex and involves diverse activities, such as production, processing and marketing. It also involves several technologies at each level in the commodity chain that makes up the system. Drawing from conclusions of several studies conducted in major West and Central Africa cities, the major players in the production, processing and marketing of these products are women (Tegegne 2004).

2.3.1 Role of Urban and Peri-urban Livestock Production UPLP in Household Food Security, Nutrition and Poverty Reduction

Urbanization poses a lot of challenges to the world's rapidly growing cities. Farming in and around urban areas has been confirmed to boost food security in these rapidly growing cities of the world. The food supply needs of about 700 million city dwellers representing about one-quarter of the world's urban population is projected to be concentrated in urban areas of developing countries by 2030 and it has been suggested that this can be met through urban agriculture (FAO-World Environment Day 2005). Urban agriculture as defined earlier, involves using plots such as vacant lots, gardens or roof tops in the city for growing crops and even for raising small livestock or milk cows (Lee-Smith and Lamba 1991; Gumbo 1994; Mougeot 1994; Mougeot 1998; Mougeot 1999; Jacobi et al. 2000; Jaiyebo and Ajayi 2004).

A related practice to UA is the peri-urban agriculture, which consists of farm units near cities that grow vegetables, raise chickens or livestock, and produce milk and eggs. Urban and peri-urban agriculture can help improve food security in several ways like providing home grown food or via a co-operative action that reduces the cost burden of acquiring food for the poor, puts more food within their reach, and reduces seasonal gaps in fresh produce. Also, by increasing the diversity and quality of food consumed, it can significantly improve the quality of urban diets. Marketable surplus can also generate income that can be used to buy more food for the household.

Mougeot (1999) noted that most urban farmers are low-income men and women who grow food largely for home consumption. This is in accordance with observations of studies on urban agriculture conducted in most West and Central African countries (Thys et al. 2005; Adesehinwa et al. 2004; Mfoukou et al. 2001; Lanjouw et al., 2001; Gefu 1982; Thys and Ekembe 1992). The role of urban agriculture especially in poverty alleviation among low-income households cannot be overemphasized in its contribution to reducing food insecurity by improving food intake of these households. Nugent (2000) considered this kind of urban production as consumption smoothing for poor urban dwellers.

2.3.2 Role of Livestock Keeping and Environmental Management

Sustainable agricultural intensification largely depends on the integration of animals, crops and people in many ecological zones. The absence of animals (or their services) from these agricultural systems means either that agricultural intensification would be made impossible or that it is most likely to occur with the use of inorganic fertilizers and mechanized traction, both of which have associated environmental costs. There have been controversial views on the contribution of animals in agricultural systems to maintaining nutrient balance; studies showed that only a percentage of the nutrients taken by animals are restored by the use of manure. Also studies have shown that the supplementation of animal feeds with minerals (i.e. phosphorus) could have the dual effect of improving animal productivity as well as contributing to soil fertility. This is an important issue in terms of food security and natural resource management, especially for smallholders cultivating marginal lands and areas that are densely populated and undergoing environmental stress as a result.

In the de Haan et al. (1997) study, emphasis was placed on the trends and projections for the relative productivity of the different identified livestock systems (grazing, mixed and industrial). In their study, they noted that despite increases in feed prices, industrial systems of livestock have continued to grow rapidly and received more support than the other systems. They therefore concluded that industrial livestock systems have much higher prospects of meeting the growing global demand for animal products than do grazing or mixed system. This conclusion may be contrary to what is obtainable in the less developed world where most supply for animal products is through small livestock producers usually in backyard farming or on a small-scale.

Global discussion on the damaging effects of the environment and human well being caused by livestock production has taken place on a wide variety of issues and themes ranging from nutrient cycling to types of subsidies and financial incentives. Many of these issues have been priority areas for developed nations and international organizations as identified by Whalen (1998) from the International Development Research Center example. The center identified and defined the scope of its programming within six thematic areas and they are each multidisciplinary in nature and were chosen for the following attributes: (i) their contribution to poverty alleviation and sustainable development; (ii) their correlation to priorities of developing countries themselves; and

(iii) their relation to IDRC's own expertise.

The six themes are:

- Biodiversity conservation
- Equity in natural resource use
- Food security
- Information and communications
- Strategies and policies for healthy societies; and
- Sustainable employment.

Issues of priority attention are those related to livestock-environment-human interactions. Studies such as the present one can thus be used to proffer policy formulations that would help to reduce human and environmental health risks associated with urban and peri-urban livestock keeping.

Often livestock production activities have in one way or another been associated with and blamed for deforestation, soil degradation, water contamination and other human and environmental health problems. It has been argued that the way in which livestock and natural resources are managed causes these problems and therefore management should be blamed for most of the environmental degradation and not the livestock themselves. Much of the degradation attributed to livestock can also be restored by livestock- if they are properly managed. The role of livestock in environmental management centers on ways of preventing degradation (nutrient cycling and terracing for example) or conservation. Recent advances are to understand the need to replenish soil fertility in many areas such as mixed farming systems in sub-Saharan Africa which could create opportunities to further understand the roles that animals can play. It is also known that in order to re-capitalize soil productivity, farmers require a short-term return on their investment and effort. Dairy production has been emphasized in mixed livestock production systems as one of the key ways in which farmers can be encouraged to invest in restoration of their soils. But the mixed intensification grazing system tends to serve a dual purpose of freeing-up land for restoration while increasing revenue that could be invested in recovery. This type of activity has many benefits that could accrue to the communities but these are likely to be constrained by a number of social, economic and political factors including land and animal tenure and markets.

2.3.3 Review of Earlier Studies on Socioeconomic Determinants of Urban Livestock Production Systems

The focus of this section is to evaluate methods and findings of studies that have been conducted in the present country of study location, in other countries and regions as they relate to socio-economic factors influencing urban and peri-urban livestock keeping, households' health risk perceptions and attitudes associated with livestock keeping. There seem to be an over-whelming number of studies on the socio-economic determinants of households involved in urban and peri-urban livestock keeping in other major cities of Africa.

Gabel (2001) in her study in Harare explored the practical and strategic needs of urban farmers who occupy the role of provider within their households using ethno-methodologies based on feminist principles. She also employed the participatory rural appraisal method to rank household activity. The strengths and weaknesses in using such an approach were revealed in the study. The study revealed that some of the women interviewed and who were also involved in urban farming experienced net economic loss. The concluding remark from the findings is that UA is not necessarily a significant method to alleviate household food insecurity for this group of women. But despite this finding, other considerations such as social and emotional benefits that have no dollar value have significant importance to these practitioners. Access to land and fear of cultivation as well as informational needs for accessing land and technical urban farming were key needs these women farmers expressed as constraints. The implication of this finding is that UA could be used as a tool to alleviate poverty when the necessary policies are put in place.

Speybroeck et al. (2004) in their study aimed at identifying location and household characteristics influencing the choice of keeping livestock or crop cultivation in Brazzaville, a post-conflict region in Central Africa. A random survey of 2800 urban households was analyzed using both non-parametric (classification tree method-CART[1]) and parametric techniques to understand how urban agricultural components have developed in the city of Brazzaville. Major socioeconomic variables for the engagement of keeping livestock or urban agriculture were identified through the use of the CART method. Amongst the variables identified were: property size, locality, income, availability of water, professional activity and other surrogate variables such as age, gender and availability of electricity. Through field interviews, four major categories of urban people were identified based on their engagement in agricultural activities. These groups were: (a) households keeping livestock only; (b) households practicing crop production only; (c) households keeping livestock and cultivating crops; and (d) households that do not engage in any of the farming activities.

In the parametric technique, a multinomial logistic regression analysis was then applied to the categorical responses to identify the regression variables that best predict the motive and types of farming systems practiced in the area. For the regression variables, major socioeconomic factors identified as determinants for engaging in urban farming or livestock keeping were: location of the household, characteristics of the household head, historical background, measure of standard of living and variables related to the professional activity of the household head.

The result from the parametric analysis revealed that people in the study area (in this case, city of Brazzaville) with no experience in crop production are also predominantly inexperienced in keeping livestock. Characteristics of the household head such as the family size, number of dependent children/persons under responsibility and ownership of property or not are some of the factors that do not have any discriminating power and therefore do not influence the choice to engage in livestock or crop production in their study. Factors identified that do influence this choice with discriminating power are location of the households, income, rate of illiteracy and past involvement in agricultural activities. Subjects with their households located in the city fringes (semi-urban) and with low income are strongly more influenced to keep livestock while those in the urban areas and with higher income have lesser involvement. On the other hand, the CART or non-parametric approach was used in selecting variables and their combinations or interactions with each other to produce classification trees that are most important in determining a dependent categorical variable.

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[1] CART is a non-parametric technique used in the study analysis and means Classification and Regression Tree. The method is used to select from a large number of variables with those variables and their interactions that are most important in determining the outcome variable to be explained.

The result from the CART analysis indicated that the illiteracy rate tends to influence the engagement in livestock and crop production in Brazzaville. This finding therefore seems to confirm studies by Siegmund-Schultze et al. (1999) and Siegmund-Schultze and Rischkowsky (2001), that keeping small ruminants (sheep) in West Africa was related to the size of the household and the rate of illiteracy. A comparison of the result from the two methods highlighted the shortcoming of the data set used in studying urban farming. It was therefore suggested that combining information from the classification tree analysis with that from the multinomial logistic regression model could be a useful tool for further analysis of livestock and crop production systems.

Empirical evidence has shown that livestock keeping in urban areas, especially small ruminants, can be seen as one activity poor urban households have adopted in meeting the increasing demand for livestock products in the cities. A survey study of 249 smallholders with urban livestock breeder profiles in Brazzaville revealed that, small ruminants production was the privilege of old males and retired, unemployed people, mainly housewives and other producers who generally are unemployed or inactive people and considered as members of vulnerable groups. It was noted that heads of households might have started small ruminant production as a strategy to vary their sources of income. It was also revealed in the survey that three main types of flocks are kept in the densely populated urban and the peri-urban zones. It was observed that more sheep are kept than goats in pure or mixed flocks (Mfoukou et al. 2001); this was adduced to the easier management of sheep than goats. Average flock size was 8.78 head of sheep and goats combined which varies by nature of the herd and location. Further data analysis involved a non-parametric technique using a regression tree to obtain information on socioeconomic parameters. The main socioeconomic factors, considered as parameters, that influenced professional activities of the respondents were gender, age, number of children, the household size and flock size (although no relationship was found between the flock size and the professional activity).

The household characteristics of these smallholders revealed that more than half of the people surveyed (about 56.8%) are old males (more than 50 years) and retired owners (about 28.9%). In the regression analysis, it was revealed that age and sex had very strong influence on the kind of professional activity practiced by the respondents. The family structure of unemployed owners of small ruminants in the study showed that the number of children was less than one; this implies relatively young unemployed people with no children or small family size practiced this kind of activity. Respondents who are traders or self-employed also have small family size but relatively more children than the previous group. Both technical and non-technical production constraints such as feed related constraints, problems with neighbours, technical knowledge, workforce, theft, technical assistance and credit were identified as some of the limitations of these households. It was therefore concluded in the study that small ruminant production as a survival strategy for urban households may be seen as a reality in responding to crisis.

The social profile of livestock keepers and their motivations as described by Thys et al. (2005) in a survey helped to determine how important urban livestock production (ULP) is to households in Ouagadougou, an urban area in Bourkina Faso. These households' profiles were compared with those of other urban dwellers to identify the major constraints related to ULP and the way livestock keepers are coping with them. It was observed in the study that household heads keeping livestock and/or crops had larger household sizes, they are older; usually with the males less educated and families live in town further away from non-livestock keeping households. It was also revealed in the study that income generation was one of the major motivations for keeping livestock, followed by food provision plus revenue generation and home consumption. Other motivations include tradition, hobby and culture etc. Almost 84 percent of all households surveyed attributed that ULP contributes to the well-being and/or survival of urban dwellers. Therefore ULP can be seen as an essential strategy for survival of these households.

The importance of livestock keeping, especially small ruminants, in urban centres has also been noted in a study conducted by Nwafor (2004) in The Gambia. The important role small ruminant play for resource poor farmers in Africa was revealed. The study also revealed that ownership of these livestock is widespread among the rural populace with little variation between ethnic groups or geographical areas. Thys and Ekembe (1992) work also supported this role by determining the importance of small ruminant rearing within the urban region. In a survey of 542 compounds in northern Cameroon concerned with rearing and/or domestic slaughtering of small ruminants, they found that most households kept more flocks of sheep than herds of goats (about 8.71 times greater than the goat). In cases where mixtures of flocks are kept, about 84 percent kept only sheep within the households sampled. The Muslims kept more sheep than goats and this was the same situation found in the region studied by Nwafor. This was attributed to the cultural and religious roles livestock keeping played in most African urban cities. Most breeders also raised small ruminants for personal consumption and animals are kept in-doors by those in the urban centres and allowed to move freely in the peri-urban areas. The penned animals require more feed inputs while the free ones scavenge on wastes by the roadsides and return to the compound at night. This supports the findings by most studies on the access to land and other production constraints faced by these households in meeting their livelihoods or livestock needs

Egziabher (1996) also examined the role and importance of UA and revealed the activity as an urban low-income households' survival strategy. In a survey of 30 households in 1991 in Addis Abba, with regard to their motivation for farming, it was observed that UA has real potential for improving diet and nutrition, generating income and employment, maximizing urban land use, reducing the costs of transport and cooling facilities, cleaning the environment and converting urban wastes into productive resources. Drescher (2004) examined poverty levels in rapidly growing Southern African cities and the contribution of UA as a livelihood strategy. Using a survey method to observe the increasing poverty level of these growing cities, the result revealed that the locus of poverty has shifted towards urban areas, making food insecurity and malnutrition an urban as well as a rural problem. Despite this, urban population in the cities of developing countries has continued to grow rapidly and the number of low-income consumers in these cities is increasing. Urban planners typically view UA as an illegal activity in the cities but it is widespread and often done under extremely difficult conditions. Urban horticulture was seen to dominate urban food production in many low-income countries. Drescher (2004) therefore suggested that technical assistance to cities is needed to take advantage of the benefits of UA for city development and urban food security. It was also suggested that advancement of UA may help solve some of the problems of city authorities through integrated programmes of wastewater re-use and organic waste recycling as well as through integration of market wastes with urban fodder consumption.

Bawa et al. (2004) conducted an assessment of the production patterns of backyard pig keeping in Kaduna metropolis using a survey questionnaire to randomly sample 170 farmers. The socio-demographics revealed that farmers involved in backyard pig farming have other occupations, which they combine with the farming activities. The other categories consist of traders, civil servants, crop farmers and lastly students in that order. More women kept backyard pigs than men, with average herd size ranging from 2-10 pigs. The management system was mostly intensive but feed inputs from this system are from kitchen wastes, vegetables and agro-industrial by-products, used as supplements. Poor management and diseases were reported as the major factor for the high mortality rates in young piglets as compared to adults. The study concluded that the productivity of urban backyard pig farming could be enhanced by reduction/removal of the identified production constraints (high cost and non-availability of compound formula feeds, credit, organized markets, high incidence of diseases, theft, poor management, lack of access to land, etc).

Smith and Olaloku (1998) identified the importance and scope of UPA and identified factors responsible for the rapid growth of this sector and the different production systems. The study also identified the major constraints to why the potential economic returns are not achieved. Technical constraints include seasonal feed shortages, as well as poor management and health care; institutional support services in terms of credit facilities, health delivery, input supply and distribution are inadequately provided. Policy-related constraints such as government policies are amongst many factors attributed for the non-optimal performance levels achieved in all the systems identified. The findings confirmed the study by Jansen (1992) which concluded that smallholder dairy production and processing in Nigeria near the urban areas in the 1980s and 1990s were not well developed and needed some kind of intervention because of their potential economic contribution.

Delgado et al. (1999) identified the implications of the global livestock revolution and the transformation of consumption and production as a nutritional transformation in developing countries which was driven by income, population and urban growth leaving little room for policy that can change the increase in demand for animal food products and the overall well-being of the poor. They identified how the “Livestock Revolution” was demand driven as compared to the supply-led Green Revolution. The study identified four key policy issues to focus on:

- Formulating policies that will not only include small-scale livestock producers’ dynamic response to the Livestock Revolution but also encourage growth, poverty alleviation and sustainability in developing countries.

- Linking, vertically, small-scale producers with processors and marketers of perishable products.
- Developing policy that will incorporate smallholders into commercial production by remedying the distortions that promote artificial economies of scale.
- Finally, development of regulatory mechanisms for dealing with health and environmental problems arising from livestock production.

Fall et al (2002) characterized the different livestock systems found in three cities in Senegal (Dakar, Thies & Saint-Louis) using a diagnostic survey. They identified two main systems of keeping livestock as urban and sub-urban (peri-urban) livestock systems. The latter uses more integrated systems and can be further divided into three sub-systems according to soil type and climatic conditions of the study area. The former production network is more family-based and most families keep domestic animals such as poultry or a few small ruminants. Sheep production predominates but cattle production is on the increase. In this system, production is not based on economic reason but more on cultural beliefs of the people "that animal protects human beings from calamity". Animals are fed on household wastes and scavenge freely in towns. Within this urban family based system of livestock keeping, cases of animal fattening and intensive poultry production especially for sale at religious events are common. Producers are faced with both climatic and land tenure constraints but despite these, UPLP[2] is an important sector in the major cities in Senegal but some stakeholders hinder its development because it competes with "regular" urbanization for space. The study therefore suggested that the potential contribution of urban livestock to food security and income generation should not be marginalized but effort should be made to overcome the economic and environmental constraints.

An exploratory survey of 3,000 horticultural households conducted in Dakar by Diao (2004) showed that the intra and peri-urban production systems are much more diversified in terms of the type of products produced (vegetables, fruits, flowers, milk, meat, eggs, etc) and the farmers' socio-economic profiles (usually young people, immigrants, less qualified populations, civil servants, contractors, etc). The peri-urban livestock production system identified in the region was dominated mainly by poultry farming and sheep breeding. Diao noted that despite the threat to the survival of UPA by many constraints, the production system seems to improve the urban life framework and also plays a positive role in the use of urban wastes (Cofie et al. 2003; Drechsel and Kunze 2001).

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[2] UPLP – Urban and Periurban Livestock Production

2.3.4 Summary

From the review, four broad classes of global livestock production systems were identified and one commonly recurring class is the landless livestock production system common in urban and peri-urban household locations. Another common factor identified in all the studies reviewed is the use of unpaid family labor by these smallholders who sometimes operate on a commercially oriented scale. Commonly kept livestock are either monogastric (pigs/poultry) or ruminant animals that scavenge or rely on household wastes for their feed. Most of the practitioners are low-income men and women who produce mainly for household consumption and also generate income from marketable surplus. Another distinguishing factor in most of these studies reviewed is that more women are involved in urban and peri-urban livestock keeping than men. Most importantly, UPA is seen as an essential survival strategy for most of these urban dwellers that fall within the low-income household's category in most of the studies reviewed.

2.4 Changing Global Environment and Evolving Livestock Production Systems Associated with Zoonotic and Food-Borne Diseases

The current emerging animal and zoonotic diseases have resulted in an increased demand for veterinary disease surveillance systems. The World Health Organization (WHO) developed a component of public health activities known as Veterinary Public Health (VPH) to address the changing global environment and the evolving livestock production systems with respect to zoonotic and food-borne diseases. This component was primarily devoted to the application of veterinary skills, knowledge and resources for the protection and improvement of human health (FAO 2003). From the definition of VPH, it was seen as a restrictive measure in applying veterinary knowledge and skills to protect and improve human health. This approach does not incorporate the coordinated effort necessary from all related disciplines in a rapidly changing environment to achieve the goal of protecting human health.

Over the years, new VPH concerns have been discovered and evolving epidemic diseases that pose high threats to humans have been found, especially in developing countries. But with the rapidly changing environment, studies have shown that developing countries have not been able to respond positively to new structures and initiatives in major public health problems. Amongst such problems was the discovery of the Nipah virus from 896 farms in Malaysia between October 1998 and May 1999 in which 901, 228 pigs were destroyed following diagnosis of the unknown virus. The disease related to the virus was discovered after 257 human cases and 100 human deaths of febrile encephalitis were diagnosed in abattoir workers exposed to the body fluids of slaughtered pigs. The outbreak later accentuated the need for speedy diagnosis and early assessment of VPH implications (FAO 2002).

The Rift Valley Fever (RVF)[3], a mosquito-borne viral zoonotic disease was another major VPH problem confined only to regions of eastern and southern Africa where sheep and cattle are raised, but the virus also exists in most countries of sub-Saharan Africa and in Madagascar (FAO 2002). But after this, the first major outbreak was detected in Egypt in 1977 and again in 1993 that resulted in an estimated 200, 000 human cases with some 600 deaths. The disease also caused numerous deaths and abortions in sheep, cattle and other livestock species. Another serious outbreak was experienced in East Africa following heavy El Nino rains in 1997-98 and this caused losses to livestock and human deaths that disrupted the valuable livestock trade to the near East. For the first time in the history of the disease in September 2000, an outbreak of RVF was recorded outside the African continent in Saudi Arabia and Yemen (FAO 2002).

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[3] RVF is an acute fever causing viral disease that affects domestic animals (such as cattle, buffalo, sheep, goats, and camels) and humans. The disease is most commonly associated with mosquito-borne epidemics during years of unusually heavy rainfall.

Of the major VPH concerns was the outbreak of BSE[4], a Prion disease of cattle and its first occurrence was recognized in the United Kingdom in 1986. Since then, over 180, 000 cattle have died or have been slaughtered. The disease which is associated with the feeding of contaminated meat/bone meal has recorded its occurrence in other European countries and recent cases in North America (United States and Canada). Over a decade now, there have been major disruptions in the world beef trade since the discovery of a causal link between BSE and new variant Creutzfeldt - Jakob disease (nvCJD)[5] in humans in 1996.

Crimean-Congo hemorrhagic fever (CCHF), a disease caused by a tick-borne virus (genus *Nairovirus*, family *Bunyaviridae*, was discovered in Crimea in 1944. It was later recognized in 1969 as the cause of illness in the Congo, thus resulting in the current name of the disease. Several incidents of the disease were noticed in abattoirs which indicated that traditional procedures of ante and post mortem inspections needed to be complemented or revised, taking into account risk factors associated with procurement of animals (FAO 2002). For instance in 1996, an incidence of the disease was recorded in an ostrich abattoir in South Africa where 17 abattoir workers contracted CCHF after handling a carcass suspected of being in the viraemic phase of the disease. The abattoir workers who contracted the disease were all working in the defeathering section, where the process of removing hard feathers from dead ostriches resulted in scratches and other injuries on their hands that gave entrance to infected blood from the sick ostrich (CDC Fact Sheet, 2005).

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[4] BSE is Bovine Spongiform Encephalopathy commonly known as 'mad cow disease."

[5] Creutzfeldt-Jacob Disease (CJD) is one of a small group of fatal diseases caused by infectious agents called prions. These attack the brain, killing cells and creating gaps in tissue and the disease is always fatal. There are two types of CJD: classical and the variant of CJD. Source: Public Health Agency of Canada , May 2003

Anthrax is also a major global disease prevalent in many countries. Serious outbreaks resulting in deaths among domestic and wild animals have occurred in recent years in Africa and Asia, where there have also been human fatalities through eating infected meat. Poor livestock farming communities are particularly vulnerable to this disease (CDC Fact Sheet, 2005).

The most recent major VPH concern is Avian Influenza (AI); epidemics of the disease have occurred in a number of countries in recent years[6], causing severe losses in poultry flocks. The AI virus strain that caused a major outbreak in Hong Kong in 1997 also caused human disease with deaths. The risk of a pandemic human influenza strain emerging from co-infection of a human influenza carrier by avian influenza H5N1 virus was reported by Ferguson et al. (2004) to be small. However, the potential global public health impact that could result in catastrophic or human pandemics cannot be ruled out. That is why studies like this can help to shed more light on how people perceive risks associated with living in close contact with livestock in their neighborhood.

2.4.1 Overview of Major Potential Human and Environmental Health Risks Associated with Urban and Peri-urban Livestock Keeping

Lock and de Zeeuw (2000) gave a summary overview of major potential health risks identified as of general concern from major agricultural activities that could be associated with UPA. Many are not specific to UPA but are grouped into health risks from communicable and non-communicable diseases listed in Table 2-1. Health risks associated with animal husbandry summarized in the table are of importance to this current study and evidence of overlap of these health effects on humans and the environment will be reviewed in subsequent sections of this literature review.

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[6] Nigeria had a major outbreak of the epidemic disease this year in poultry farms located in some major cities where the first case was reported on a farm located in our study area (Kaduna State)

Alberta Agriculture (2003) in its environmental manual for dairy producers in Alberta, identified air quality, odour, dust, gases, pesticides, pathogens, pharmaceuticals amongst others as major environmental risks and nuisances associated with livestock production. These potential hazards such as dust, odour and fumes might not have direct effect on humans and the environment but they become health concerns when the minimum threshold values are exceeded as in the presence of contaminants in the air or soil. The question here is to identify how these minimum or acceptable thresholds can be quantified. It is also necessary to determine at what levels these minimum thresholds become health concerns to those involved in livestock keeping and to their neighbours.

Lock and Van Veenhuizen (2001) in their study tried to demystify the negative support UPA has received from many governments and municipal authorities for planning and development of agricultural activities within city limits. The study recognized and highlighted the major health benefits of urban and peri-urban agriculture despite the associated potential health risks and these benefits range from:

- Increased urban food security;
- Improved sanitation solutions and waste recycling;
- Improved nutrition;
- Income generation and poverty reduction;
- Improved physical and psychological health due to increased physical activity.

The study also pointed to the many health risks that have been linked to urban agriculture, which can help to secure support of municipal and national authorities when these activities are carried out in safe and environmentally sustainable production methods. The main health risks identified to be associated with urban and peri-urban agriculture are as follows:

- Contamination of crops with pathogenic organisms due to irrigation by water from polluted sources or inadequately treated wastewater or organic solid wastes;
- Human diseases transferred from disease vectors by agricultural activity;
- Contamination of crops and/or drinking water by residues of agrochemicals;
- Contamination of crops by intake of heavy metals from contaminated soils, air or water;
- Transmission of diseases from domestic animals to people (Zoonoses) during husbandry and processing or meat consumption;
- Occupational health risks for workers in the food-production and food-processing industries.

It was noted in the study that the major health risk that should be of great concern to practitioners of urban agriculture is health risk linked to the use of wastewater and solid waste. One of the major ways suggested to minimize this health risk include self-help projects but this has suffered from lack of interest and capability of authorities to intervene at the policy level. The study therefore stresses the need to address the potential hazards of UPA to protect the producers, their families and consumers from contaminated foods and occupational hazards. It also emphasizes the need to determine the actual and perceived health and environmental risks of UPA in order to secure support of municipal authorities and state officials.

Table 2-1: Major Agricultural Activities and their Associated Health Risks Categories

Agricultural activities	Communicable diseases or health risks/hazards	Non-communicable diseases or health risks/hazards
Crop production	Using untreated or inadequately treated domestic wastewater for irrigation. Using manure inadequately produced from compost infected with bacteria (shigella, typhoid and cholera), worms (like tape and hook worms), protozoa, enteric viruses or helminthes (ascaris, trichuris). Mosquitoes breeding in shallow clean irrigation water, standing water polluted with organic materials and water logged farmlands. Contamination of food by bacteria due to poor hygienic conditions in informal food preparation and marketing causing diseases such as salmonella and E-coli.	Heavy metals and other hazardous chemicals from soils, irrigation water or sewage sludge polluted by industry can be taken up by crops in the soil. Growing crops close to main roads or industry and purchasing contaminated food from street vendors with air-borne lead and cadmium. Presence of agrochemical residues in crops and drinking water e.g. pesticides and nitrates. Occupational injury causing disability and exposure to agrochemicals.
Animal husbandry	Interaction between animals and humans could lead to occurrence of zoonotic disease like bovine tuberculosis and tapeworms infecting livestock meat. Also of greatest concern now is the Avian flu in poultry birds. Contamination of drinking water with pathogens by applying animal waste to land (slurries). Animal products contaminated with pathogens from contaminated feed with infected faeces (salmonella, campylobacter).	Animal products (like red meat, poultry meat and eggs) may be contaminated with pesticides and/or antibiotics under intensive systems. Traffic accidents caused by roaming animals and attacks on humans. Occupational diseases such as asthma and allergic reactions due to livestock wastes/dust (especially from poultry). Presence of hazardous chemicals in tanneries' wastes e.g. tannin, chromium, aluminum.
Aquaculture	Potential risks involved when feeding fish with wastewater and/or human and animal excreta. When fish ponds are poorly managed becomes breeding ground for malaria causing mosquitoes. Development of antibiotic resistant bacteria in food chain when antibiotics are used in fish feed	Presence of heavy metals in fish products when fed with untreated wastewater or organic wastes contaminated by industry. Fish products may be contaminated with agrochemicals when raised in an input-intensive environment.

Source: Birley and Lock (1999): The health impacts of peri-urban natural resources development

2.4.2 *Studies on Potential Health Risks Associated with Urban Livestock Keeping*

Birley and Lock (1997) in their paper examined the health problems facing natural resource production in the peri-urban areas especially the expansion in the production of crops and livestock. The major health problems faced by the enterprises and the inhabitants of peri-urban areas are those risks posed by malaria, heavy metals, and the re-use of solid and liquid wastes, agro-chemicals, biomass fuels and food contamination. The study therefore suggested the need for research and risk assessment procedures that will ensure that the expansion in crop and livestock production in the peri-urban areas also safeguards human health. Flynn (1999) identified and reviewed literature on some specific health hazards related to urban farming practices and discussed practical ways to address these problems. The study identified two serious health hazards that are associated with UPA as:

- Public health risks associated with UPA practiced in areas contaminated by industrial and chemical pollutants and;
- Zoonotic diseases associated with urban livestock keeping

Lock and de Zeeuw (2001) focused their paper on how to formulate urban agricultural policies (measures) that will improve the health of urban populations. An overview of the main health risks associated with UPA was highlighted and mitigating measures were proposed. The health risks identified and the mitigating measures proposed were seen as working hypotheses that further research could be based on. The following range of measures was proposed as ways to mitigate the health risks identified under the following headings:

- Mitigating diseases associated with the re-use of urban wastes and wastewater
- Developing environmental management programmes for vector-borne diseases
- Mitigating the diseases associated with the use of agrochemicals
- Measures to reduce spread of zoonotic diseases.

Lock and Van Veenhuizen (2001) also identified positive and negative effects of UPA on the health and environmental conditions of urban populations and suggested ways of balancing these health impacts. They stressed the need to conduct a health impact assessment study that will serve as an evidence-based decision-making tool to provide a balanced view of the positive and negative health impacts of UPA. Binns et al. (2003) examined some of the health and environmental concerns associated with UPA in Kano State in Nigeria. The study showed empirical evidence from the assessment of soil and water channel pollution. Health implications of long-term exposure to toxins were not clear. They suggested coordinated longitudinal research involving planners, agricultural scientists and health specialists.

Bigras-Poulin et al. (2004) also conducted a study on the potential biological risks to human health linked to the agro-environment and assessed the population exposure associated with such diffuse potential risks. They assessed the spatial correlation between this exposure and disease occurrence in humans. To better understand the link between public health exposure and agro environmental water contamination by zoonotic enteric bacteria, they developed agro environmental indicators called "agro environmental hygienic pressure indicators" (AHPI). The indicators were identified as useful tools for ranking livestock operations according to their potential to contaminate surface or groundwater when there is adequate knowledge related to the general pathway of water contamination.

Adebayo and Sorungbe (2002) examined how much knowledge farmers have about some deadly diseases prevalent in their stock for timely re-adjustment or the prevention of losses. The study was to determine the level of farmers' awareness of African Swine Fever (ASF). Primary data were collected with the use of a questionnaire from 120 respondents using a purposive sampling technique[7]. There was inadequate awareness of the early symptoms and characteristic signs of ASF among respondents. The location of the farms does determine the awareness levels of farmers but the number of pigs is not affected by farmers' contact with extension agents. They concluded extension services to pig farmers in the area are inadequate and recommended that institutional support is needed and should be developed in cases of epidemic.

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[7] Purposive sampling technique is a non-probability sampling used primarily by researcher when there is a limited number of people that have expertise in the area being researched

2.5 Dimensions in Risk Management Process and Risk Perception Studies

Over the past decade, risk assessment and management as noted by Power and McCarty 1998), was one of the most important environmental policy developments in many modern societies. Human activities in most of these societies are recognized to both depend on and have consequences on the environment. The effects of these human activities were also noted to have impact on sociopolitical institutions and environmentally dependent systems, such as the economy, human health, and natural ecosystems at different spatial and temporal scales (Power and McCarty 1998). Risk management is getting more and more important as numerous risks tend to emerge in different ways. This has also led to the development of many generic models within the field of risk management and one commonly used model is the International Electro-technical Commission (IEC)-model[8]. In this model, three major parts of the risk management process are presented (Fig 2-1). The *risk analysis* as the first part of the risk management process includes both *identification* and *assessment* of the risk in which *risk perception* plays a very important role in the risk analysis. Risk analysis is defined as a systematic approach that is aimed at assessing the likelihood of an adverse effect of an agent or action and suggests intervention strategies (Mohamed 2004).

From an engineer's point of view risk is defined as a numerical value, which is a function of probability and consequence. Wynne (1992) viewed risk from a social scientist's perspective as a social construct that depends upon the social context and the conditional knowledge in which it is being used. The basis for the risk assessment therefore is to assess risks and determine if they are acceptable or not. From this assessment base, decisions are made as to whether to invest in actions against the risks or not. In the risk assessment context, "perception" refers to the individual's judgment as to the acceptability of a given hazard situation (Short 1984). While the phrase "perceived risk" has been used more often in risk assessment literature, it is basically used in comparison with "real risk". "Perceived risk" can be viewed as how a layman understands various risky situations while "real risk" refers to expert or scientific understanding of these risks

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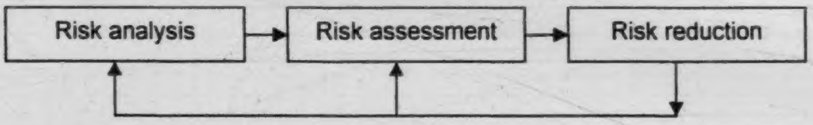
[8] International Electrotechnical Commission (1995)

(Coleman 1993). Studies have shown that individuals vary significantly in their tolerance for various hazard situations. Risk-analysis theory therefore acknowledges that laypersons differ from experts in the manner by which they form risk judgments. For instance, experts tend to form risk judgments by considering the potential severity or harm that might result from an event as well as the probability that an event may or may not occur (Slovic 1987; Frewer 2000). Laypersons, in contrast, often de-emphasize the concept of probability when forming risk judgments and rely more heavily on qualitative aspects of the risk event, such as whether it can be controlled, avoided, or easily understood (Covello and Johnson 1987; Pidgeon and Beattie 1998).

Figure 2-1: Risk Perception and Management Process



Simplified version of the IEC-model

Source: Adapted from Risk Perception and Management (Anders Jacobson, 2005)

A common underlying assumption used for risk assessment is that there is no threshold of harm. The risk assessment process is generally divided into four stages which include: hazard identification, hazard characterization (determination of exposure-risk relationship), number of people exposed to the risk, and levels of exposure. This helps to suggest a decision-aiding stage based on the assessment of alternative prevention policies (risk management). These stages are more useful when conducting an epidemiological study of various health risks such as those associated with livestock keeping. Since this is beyond the scope of this present study, this study therefore limits the area of coverage to just the risk assessment stage and specifically the risk characterization aspect.

2.5.1 Psychological and Cognitive Dimensions in Risk Perception

Several research studies based on the psychological and cognitive dimensions in risk analysis have focused on environmental attitudes and risk perception. One of such studies examining environmental attitudes and concern was to determine whether differences occur between rural and urban households (Freudenburg 1991). These findings indicated that persons in the agricultural sector have higher environmental concerns than other rural persons in the same communities. Such differences are hypothesized to exist due to the greater dependence of rural households on extractive uses of the environment as compared to urban households (Freudenburg 1991; Tremblay and Dunlap 1978). The rural dependence on natural resources is expected to lead to a more utilitarian view of the environment among rural households than their urban counterparts, who are less directly dependent on the extractive uses of the environment and are anticipated to have a greater affinity for environmental quality goals. A study by Jones-Lee et al. (1999) identified few differences between rural and urban households in both cognitive and behavioural indicators of environmentalism when controlling for other socio-demographic factors. However, support for this hypothesis of rural/urban differences is still mixed.

Individuals and societal perceptions of and responses to environmental health risks are multidimensional and complex. Studies have shown that social, political, psychological, and economic factors interact with technological factors affecting perceptions in complex and integrating ways. Studies conducted to determine environmental and health risk preferences, for instance the work of cognitive psychologists such as Slovic et al. (1981) and economists Jones-Lee (1989) and Viscusi (1992); suggested the importance of including additional factors such as the way people think and feel about health risks (subjective judgments). They also tried to explain what determines peoples' attitudes towards such health risks. Standard questions from the health and psychology literature as well as those from psychometric literature on risk perceptions were developed from such studies and have been used by many researchers (Wallston et al. 1978; Slovic et al. 1981).

Research studies on risk perception started with the nuclear debate in the 1960s and this was followed by Starr's seminal work. Originating from work on "revealed preferences," (Starr 1969) much attention has been focused on the characterization of risk through the use of psychometric scales and factor analysis. Starr showed that risk acceptance was related not only to technical estimates of risk and benefits but also to a subjective dimension such as voluntariness. Despite the criticisms of Starr's choice of data, the seminal work opened up a new area of research. In explaining risk perception, several factors have been suggested as the determinants of this curious phenomenon. A useful concept that most authors failed to mention for various reasons is the real risk factor. In some studies, this real risk factor has been suggested as a very important determinant of perceived risk in some contexts.

The seminal paper by Fischhoff et al. (1978b) stimulated the establishment of the risk perception model called the 'psychometric model'. The underlying theory of this model is that the public's perception of risk is driven by emotional reactions--often referred to as dread or 'gut feelings'-- and ignorance. Further research by Slovic (1987) examined the major attributes of risk and how these attributes influenced risk perception.

Flynn et al (1994) found that socioeconomic characteristics, voting behaviour and the level of knowledge an individual has concerning a specific risk could influence that individual's perception, for instance, perception of health and food safety risks. Therefore, understanding how individuals perceive risks and what socio-economic characteristics are suggested as the best predictors of these risks could assist decision makers in policy formulation.

Sjoberg (2000) found in a study that policy with regard to risk mitigation or reduction was mostly driven by general risk in the case of lifestyle risks (smoking, alcohol consumption, etc.) while in the case of technology or environmental hazards this was driven more strongly by personal risk.

2.5.2 Approaches Used in Risk and Risk Perception Studies

Several studies reviewed have suggested that perceptions are important factors influencing human reactions and response to hazards. Different theoretical and methodological approaches have been used in research to study risk and risk perception. Three prominent empirical approaches that have been used by researchers in the assessment of perceived risk are the psychometric paradigm perspective, the cultural and the reflexive modernization theory approaches. The psychometric approach represents a cognitive or social-psychological view in evaluating risk perception. The second approach focuses on an anthropology perspective while the third is a sociological view of risk perception. Many researchers in psychology have used several ways to examine the effect of one factor at a time on a particular behavior. Some investigators have also set up experimental designs to test the behavioral effects of several factors in various combinations while others study behavior in the "real" world by observing people in their daily activities. The two commonly used and widely adopted models in assessing risk perception are the psychometric model and the cultural theory model. For the purpose of this study, the focus will be on the first two approaches commonly argued and cited by researchers. In the sections that follow, the premises upon which these two approaches are empirically used in risk perception and how results from such studies are effectively interpreted are briefly highlighted.

2.5.2.1 Psychometric Theory of Risk Perception

The psychometric approach to risk perception is a quantitative methodology of the study of human behavior. The "psychometric paradigm" is a research method developed by Slovic (1997; 1992) to study the social risk perception and acceptance to risk of certain activities and technologies. The approach has been used frequently by psychologists. From this perspective, researchers attempt to identify underlying factors associated with perception of risks so that information can be used in risk assessments and policy decisions. Fischhoff et al. (1978b) launched the psychometric model in a research paper and developed a set of traditional rating scales in assessing risk perception of identified nuclear hazards. The model asserts that perceived risk is a function of a number of risk attributes such as the voluntariness of the risk, new risk versus old risk, etc., and this forms the basis for the psychometric model of risk perception. Slovic et al. (1981) also used this model in earlier studies to support the high proportions of explained variance obtained when rating a fairly large number of hazards. Average ratings were used in their study that resulted in strong correlations between mean perceived risk and mean ratings of the risk attributes.

A large body of research has also found that people's perceptions of the acceptability of risks are largely influenced by the characteristics of the hazards they face (**see** (Fischhoff et al. 1978b; Wandersman et al 1989; Johnson and Tversky 1983). Slovic and co-worker (Fischhoff et al. 1978b) used this approach to examine reactions to a variety of hazards and discovered that the degree to which a hazard was dreaded was closely linked to the level of riskiness attributed to that hazard. This basic finding has been replicated in numerous studies across a wide range of hazards and risk scales. The dread factor consistently emerges as the most important factor in explaining perceived risk (Slovic 2000). Another factor which repeatedly emerges as important in determining the level of perceived risk is the degree to which a hazard or concern is known or unknown (Peters and Slovic 1996). Other researchers who have applied this approach in their studies include: Frewer et al. (1998); Sjoberg (2000); Finucane (2002) and Townsend et al. (2004). Other applications of the approach were studies conducted by Marris et al. (1998), they investigated the relationships among risk characteristics across 13 hazards using single level respondents.

Recent studies that have applied the psychometric approach to investigate relationships between risk perceptions and standard socio-demographic variables such as gender, age, occupation, nationality or place of residence no longer incorporate analysis of the "qualitative risk characteristics" which originally formed the basis of the psychometric paradigm. This was attributed to the fact that the correlations observed in such studies tended to be very weak. Even when correlations were identified, this approach provided very little meaningful insight into why some types of people (e.g., women) perceived risks differently. It was therefore concluded that the influence of factors such as gender, age, or place of residence apparently relate to underlying factors or dimensions that were not clearly revealed in these quantitative cross-sectional studies (Flynn et al 1994; Marris et al. 1998).

This approach has also been subjected to two main criticisms of treating the "qualitative risk characteristics" as inherent attributes of the hazards themselves, rather than as constructs of the respondents. The second criticism of the approach was that analysis was based on experts and laypersons opinion rather than distinguishing between groups of respondents. Most psychometric studies generally use questionnaires and statistical methods for investigating a number of risks selected by the researcher. The main aim has been to find underlying dimensions (e.g., involuntary exposure, potentially catastrophic consequences, lacking scientific knowledge about the risk) that may explain why some risks are perceived to be more risky than others (Slovic 2000).

2.5.2.2 The Cultural Theory of Risk Perception

The cultural theory used in risk perception is based heavily on the work of Douglas and Wildavsky (1982) and later studies by Dake (1990; 1991). Douglas and Wildavsky (1982) suggested that perceptions of risk should be thought of in a cultural context and that such perceptions may be biased by political, economic, and cultural propensities. Wildavsky and Dake (1990) launched the initial empirical and quantitative support for the theory. They based their argument on the premise that particular forms of social organization or social institutions influence perceptions of risk. The theory specifies four groups of people that will "choose" to be concerned with different types of hazards. The four types of people identified are:

- The *egalitarians* concerned with environmental and technological hazards
- The *individualists* group concerned with war hazards and threats to the markets
- The *hierarchists group* concerned with law and order hazards
- The *fatalists* group not concerned with any of the above hazards

The theory also strives to explain why there are wide and deep disagreements about risks. For instance why different people worry about different risks, and why people's knowledge about risk does not necessarily correspond with their actions. The theory further gave insights to why each social institution has its own "worldviews or ideologies entailing deeply held values and beliefs defending different patterns of social relations" (Wildavsky and Dake 1990). This further explains why people do not predict the probabilities of risk accurately and why people perceive risks differently.

The basic argument stressed by Douglas (1986) in this theory is that "the institutional filter through which risks are perceived imposes a consistent distortion upon the probabilities (of risk)". The theory critiqued the individualistic approach taken by the psychological researchers dominating risk perception research in their focus on processes of cognition and choice. The proponent of the theory also opined that cultural worldviews more powerfully explain political attitudes than do various other individual characteristics, including gender, race, income, education, and political affiliations and ideology. Despite the emphasis of this theory on the importance of culture, the proponent of the theory demonstrates a 'weak' rather than a 'strong' constructionist approach to risk. In conclusion, risk is seen as a socially constructed interpretation and response to a 'real' danger that objectively exists, even if knowledge about it can only ever be mediated through socio-cultural processes.

2.5.2.3 Summary

A brief discussion of two commonly used theoretical approaches to risk perception is highlighted in the above section. While the two perspectives acknowledge that risk perceptions are socially constructed, each perspective provides insights to a particular underlying aspect of risk perception. The psychometric approach relies heavily on empirical data to analyze underlying factors of risk perception, and attempts to rank risks according to these underlying factors. The psychometric approach also primarily focuses on cognitive aspects of risk perception while cultural theory focuses on social and structural organizations. The review also revealed the inherent weakness with the two theories in their approaches to risk.

2.5.3 Empirical Studies on Risk Perceptions and Attitudes

In the documented risk literature it has been shown that there are some systematic deviations where small risks are overestimated and large risks are underestimated (Viscusi 1998; Hakes and Viscusi 2004). But a more general trend is that there is a perception of risk by an average individual and a realistic perception of risks can be expected when people have either some direct or indirect experience with the type of risks being investigated by the risk analyst. The risk target is a factor of great importance in risk perception studies and in the present study the risk concern is two fold, that is personal risk and a general risk (i.e., risk to others, or people in general). An insight into the social basis of public concerns about livestock development based on the theory of risk analysis in a study by (Tucker, R. E, and Jeff S. 2006) specifies the role of physical proximity and social distance as major risk concerns. According to this theoretical perspective, perceptions of risk are heightened among individuals located in close physical proximity to potential hazard situations (Tucker and Ted L. Napier 1998). In addition to physical proximity, risk analysis theory asserts that trust and opportunity for economic benefits are related to public perceptions of potential hazard situations (Tucker and Sharp 2006). The opportunity for economic benefits can also play a role in the public's perceptions of risk because individuals often weigh both the risk and benefits in their determination of acceptable risk levels. Other studies also show that individuals tend to express greater tolerance for risks in circumstances where they gain an economic benefit or advantage (Covello 1998).

A review of a number of existing empirical studies on risk perceptions indicated that gender differences also occur in perceptions of risk (Flynn, Slovic, and Mertz 1994); (Gustafson 1998). Some of these studies pointed to the fact that different and sometimes contradictory outcomes in perceptions of risk by women and men occur when quantitative and qualitative approaches are used in the risk analysis. A survey conducted by Richardson and Whitney (1995) in Greater Khartoum urban areas to establish the link between animal keeping and household attitude toward problems associated with animals suggested that individuals with the opinion that urban animals are the source of urban problems are less likely to keep them in cities. They also concluded that lower income households are less likely to know the possible health problems related to animal keeping. The results of the study therefore indicated those families with lower income, education, awareness of health or other problems and with a rural background are most likely to keep animals.

A study conducted in semi-arid Tanzania by Quinn et al. (2003), examined variation in local perceptions of risk about how households view their worries and concerns in providing for themselves and their families using a risk questionnaire. The study revealed heterogeneity in risk perception in the study location and identified livelihood strategy and gender as some of the socio-demographic characteristics that can influence people's perceptions of risk in addition to environmental factors. The result of the study also showed that risks cited by men and women generally reflect their traditional role within that society or household. This study finding is in agreement with conclusions made in other risk perception studies (Fisher et al. 1991; Davidson and Freudenburg 1996; Gustafson 1998).

Fischhoff et al. (1978b) in their study developed a risk rating scale in which subjects were asked to rate 30 classified potentially hazardous activities on nine seven-point scales by indicating qualitative characteristics of risks (Table 2-2). This was based on the relationship of a combination of several factors listed in the risk dimension column in the table. Factor analysis of these ratings identified two factors: the 'dread' of the risk and the 'knowledge' of the risk as the major characteristics of the risk perception. However, this approach of using a risk-rating scale has been criticized for not considering other potential factors involved than merely properties of the risk object.

Sjöberg (1999) found the level of perceived risk to be related to the probability of harm or injury; whilst demand for risk reduction was related mostly to the expected severity of "consequences" should harm occur. In other studies by Sjoberg (2000) to improve the explanatory power of factors used in explaining risk perception, he proposed a model in which attitude, risk sensitivity, and specific fear are used as explanatory variables. The model was quite different from other approaches used in psychometric models by adding a factor of "unnatural risk" to the usual cognitive analysis of attitude.

2.5.4 Willingness-to-Pay (WTP) Approach to Health Risk Reduction

The willingness-to-pay approach is a utility measure approach used in assigning value to risk reduction by estimating what the risk reduction is worth to individuals whose health might benefit. The approach assigns dollar values to the resources that individuals are willing to and able to forgo for a reduction in the probability of encountering a hazard that may result in their dying at work (Biddle et al. 2005). WTP estimates are derived through either "stated-preference" or "revealed-preference" methods. The first method involves asking individuals directly how much they would be willing to trade for a change in fatal health risk. The second method, "revealed-preference," observes the choices individual directly make concerning health risks. Consumer's willingness-to-pay (WTP) for reduction in health risk or improvement in health can be estimated using this approach.

The WTP approach as a social welfare tool is used in the evaluation of health and safety programs and there have been a lot of critiques surrounding this approach. This analytical tool is used to measure what individuals would be willing and able to pay for a reduction in the probability of encountering a hazard that might compromise their health. These values or WTP estimates vary among individuals due to consumer preferences and the value each individual attaches to goods that are not marketed.

2.5.4.1 Stated Preference versus Revealed Preference

The Stated Preference (SP) and Revealed Preference (RP) approaches are both current valuation techniques that place a monetary value on an environmental asset (either good or service) and these methods are used for measuring non-market benefits. Three general categories of the SP method are Rating, Ranking and Stated Choice Methods (hereafter, SCM) (Adamowicz et al. 1998). The SCM has other subclasses which are the Referendum Contingent Valuation, the Attribute Based Stated Choice and other Choice Methods. The use of the referendum contingent valuation is one form of SCM that is based on the random utility theory while the "Open-ended" contingent valuation falls into the category of "ranking" because this involves ranking a scenario with a monetary metric versus some other metric, such as rating scale. Choice and ranking data generated from SCM are generally analyzed using random utility theory and utility maximization as a conceptual framework. Thus, the same econometric methods used to analyze Revealed Preference (RP) data are employed with choice and ranking data from SCM.

Generally, SP methods are more commonly known as "Contingent Valuation Methods" (CVM) therefore contingent valuation method is the most commonly used SP technique in environmental valuation as stated by Carson et al. (1994). This method constructs a hypothetical market for an environmental good and elicits the economic welfare change associated with the change in the environmental good or service. It is commonly structured as a hypothetical referendum in which respondents vote on accepting an environmental improvement (or not) in exchange for a specified payments (or no improvement), (Grafton et al. 2004). Another valuation technique in contrast to CVM is the attribute based methods which elicit information on choices of different bundles of attributes. These attribute bundles are designed to contain many attributes, including monetary attributes, while contingent valuation tends to focus on the monetary factors (Grafton et al. 2004).

Table 2-2: Risk Rating Scales

Risk Dimensions	Risk Rating Scales
Voluntariness of risk	Do people get into these risky situations voluntarily? If for a single item some of the risks are voluntarily undertaken and some are not, mark an appropriate spot towards the centre of the scale (1=voluntary; 7=involuntary)
Immediacy of effect	To what extent is the risk of death immediate-or is death likely to occur at some later time (1=immediate; 7=delayed)
Knowledge of Risk	To what extent are the risks known to precisely by the persons who are exposed to those risks (1=known precisely; 7 =not known precisely)
Knowledge of Risk	To what extent are the risks known to science (1=known precisely; 7 =not known precisely)
Control over risk	If you are exposed to the risk of each activity or technology, to what extent can you, by personal skill or diligence, avoid death while engaging in the activity (1= uncontrollable; 7 = controllable)
Newness	Are the risks new, novel ones or old, familiar ones (1=new; 7 = old)
Chronic versus Catastrophic	Is this a risk that kills people one at a time (chronic) or a risk that kills large numbers of people at once (1=chronic; 7= catastrophic)
Common versus dread	Is this a risk that people have learned to live with and can think about reasonably and calmly, or is it one that people have great dread for-on the level of gut reaction (1=common; 7= dread)
Severity of Consequences	When the risk from the activity is realized in the form of a mishap or illness, how likely is it that the consequence will be fatal (1= certain not to be fatal; 7= certain to be fatal)

Source: (Fischhoff et al. 1978)

2.6 Chapter Summary

The importance of global livestock production systems and their role in achieving household food security, nutritional balance and poverty alleviation are reviewed in this chapter. Studies on socioeconomic factors that have dictated the evolving systems of livestock keeping adopted by urban and peri-urban households are examined. In studies so far examined, general emphasis has been laid more on socio-demographic determinants of keeping livestock and less on potential human and environmental health risks associated with such production systems (Thys and Ekembe 1992; Flynn et al. 1994; Egziabher 1996; Mfoukou et al. 2001; Bawa et al. 2004; Nwafor 2004; Speybroeck et al. 2004; Thys et al. 2005). Based on findings from these studies, the common socio-economic variables found to be important across a majority of these studies include: gender, age, and educational status; household size, presence of children in the household, location, income level and occupational type.

Empirical studies on potential health risks assessment are yet to be adequately examined in developing countries especially in Nigeria based on previous studies reviewed thus far. Despite this, the environmental impact of livestock is an important issue in both developing and developed countries and in particular urban livestock keeping. Most risk assessment studies reviewed in regards with urban agriculture are based on a general overview of the main health risks associated with UPA (Birley and Lock 1997; Flynn 1999; Lock and de Zeeuw 2000; Lock and Van Veenhuizen 2001; Adebayo and Sorungbe 2002; Bigras-Poulin et al. 2004). Despite this shortcoming, a strong conclusion drawn from all these reviews is the presence of some potential health risks associated with urban agriculture. The commonly identified health risks that are likely to be present and associated with urban and peri-urban livestock keeping are: livestock waste management, water contamination from livestock wastes, zoonotic diseases, noise and odour from facilities causing environmental pollution and animals roaming around the streets.

The results from a few studies conducted examining small livestock holders' understanding of health risks indicated that inadequate awareness is a major concern among those involved in such farming practices. Animal health problems and manure management have also been consistently identified as major constraints in livestock keeping both among smallholders in urban settings (Richardson and Whitney 1995; Thys et al. 2005) and on large scale livestock facilities (Tucker and Napier 1998; Quinn et al. 2003; Sharp and Tucker 2005).

Table 2-3: Previous Studies on Urban Agriculture and Some Socio-Economic Determinants of Urban Livestock Keeping in Other Regions

No.	Author/Year/Title	Objectives of the study	Findings and conclusion
1.	Adebayo & Sorungbe (2002)	The study focus was to determine the level of farmers' awareness of ASF Primary data were collected with the use of questionnaire from 120 respondents using purposive sampling technique.	Inadequate awareness of the early symptoms and characteristics signs of ASF among respondents. Farm location determined the awareness levels of farmers. Farmers that have regular contact with extension agents their pig stock population were not affected. Conclusion: extension services to pig farmers in the area are inadequate. Recommendation: institutional support needed and should be developed in cases of epidemic.
2.	Bawa et al. (2004)	Assessment of the production pattern of backyard pig raising in Kaduna metropolis. 170 farmers were sampled randomly using structured questionnaire	Socioeconomic demographics revealed that farmers involved in backyard pig farming have other occupation. The categories consist of traders, civil servants, crop farmers and lastly students in that progression. Women kept backyard pigs than men with flock size about 2-10pigs. Management system mostly intensive but feed inputs derived from kitchen wastes, vegetables and agro-industrial by-products as supplement. Poor management and diseases identified as causes for high mortality rates in young piglets than for adults. Conclusion: productivity of urban backyard pig farming could be enhanced by reduction/removal of the identified production constraints (high cost and non-availability of compound formula feeds, credits, organized markets, high incidence of diseases, theft, poor management, lack of access to land etc)
3.	Bigras-Poulin, et al., (2004)	The study assesses the potential biological risks to human health linked to the agro-environment.	Population exposure associated with such diffuse potential risks and the assessment of the spatial correlation between this exposure and disease occurrence in humans. To better understand the link between public health exposure and agro-environmental water contamination by Zoonotic enteric bacteria, agro-environmental indicators were developed called "agro-environmental hygienic pressure indicators" (AHPI). The indicators are useful tools for ranking livestock operations

			according to their potential to contaminate surface or groundwater when there is adequate knowledge related to the general pathway of water contamination.
4.	Binns et al. (2003)	Examination of some health & environmental concerns associated with UPA. Empirical evidence from environmental assessment of soil and water channels pollution	Health implications of long-term exposure to toxins were not clear. Study suggested coordinated longitudinal research involving planners, agricultural scientists and health specialists.
5.	Delgado et al. (1999)	The paper identifies the implications of global livestock revolution and the transformation of consumption and production and how Livestock Revolution was demand driven compared to supply-led Green Revolution	(1) Suggested formulation of policies that will not only include small-scale livestock producers to dynamic response to Livestock Revolution but also encourage growth, poverty alleviation and sustainability in developing countries; (2) Linking vertically small-scale producers with processors and marketers of perishable products; (3) Policy that will incorporate smallholders into commercial production by remedying the distortions that promotes artificial economies of scale; (4) Regulatory mechanisms for dealing with health and environmental problems arising from livestock production need to be developed. Nutritional transformation in developing countries is driven by income, population and urban growth and this leaves little room for policy that can change the increase in demand for animal food products and the overall well-being of the poor. The study in conclusion identified four key policy issues to focus on.
6.	Diao (2004)	Exploitation of household peri-urban vegetable production systems. An exploratory survey of 3000 horticultural households were sampled	Found that poultry farming and sheep breeding dominated the Livestock production systems. UPA improves the urban life framework, plays positive role in the use of wastes. UPA survival is been threatened by many constraints.
7.	Drescher (2004)	Determination of poverty levels in rapidly growing Southern African cities and the contribution of UA as a livelihood strategy. Survey method was used to generate primary data for the study.	Study revealed an increasing poverty levels & a shifting locus towards urban areas. UA is typically illegal but widespread & often done under extremely difficult conditions. Urban horticulture is dominating urban food production in many countries. Technical assistance to cities needed to take advantage of the benefits of UA for city development and Urban food security. UA advanced to help solve some of the problems of city authorities through integrated Programs of wastewater re-use and organic waste recycling as well as through integration of

			market wastes with urban fodder consumption.
8.	Fall et al. (2002)	The study aimed to characterize the different livestock systems found in three cities in Senegal (Dakar, Thies and Saint-Louis) using a diagnostic survey.	Two main systems were identified: urban and sub-urban (peri-urban) livestock systems. The latter is more of integrated systems and further divided into 3 according to soil and climatic characteristics of the study area. The former production network is more family based. Most families keep domestic animals such as poultry or a few small ruminants. Sheep production predominates but cattle production is on the increase. In this system of production it is not based on economic reason but more on cultural belief of the people "that animal protects human beings from calamity". Animals are fed on household wastes and scavenge freely in towns. Within this urban family based system of livestock keeping, there are few cases of animal fattening and intensive poultry production especially for sale at religious events. Producers are faced with both climatic and land tenure constraints but despite these, UPLP is an important sector in the major cities in Senegal but its development hindered by some stakeholders because it competes with "regular" urbanization for space. The study therefore suggests that the potential contribution of urban livestock to food security and income generation should not be marginalized but look for how to overcome the economic and environmental constraints.
9.	Flynn (1999)	This paper identified and reviewed literature on some specific health hazards related to urban farming practices and discuss practical ways to address these problems	The study identified two serious health hazards that are associated with UA as: (i) Public health risks associated with UA practiced in areas contaminated by industrial and chemical pollutants and (ii) Zoonotic diseases associated with urban livestock keeping
10.	Egziabher (1996)	Examines the role and importance of UA as urban low-income households' survival strategies. Surveyed 30 households in 1991 in Addis Abba with regard to their motivation for farming.	Study suggested that UA has real potential for improving diet and nutrition, generating income & employment, maximizing urban land use, reducing the costs of transport and cooling facilities, cleaning the environment and converting urban wastes into productive resources.

11.	Islam and Berberovic (2002)	Identify the potential for and barriers to UA with reference to rooftop gardening (RTG) and explore strategies to promote food security in Dhaka.	An exploration study of socioeconomic and institutional conditions that might hinder UA was conducted. Urban population in the cities of developing countries is rapidly growing. Number of low-income consumers is increasing. Policies that effectively integrate agriculture into urban environment suggested.
12.	Lock and van Veenhuizen (2001)	To identify the positive and negative effects of UA on the health and environmental conditions of the urban population and suggesting on ways on balancing these health impacts.	The need for a health impact assessment study that will serve as an evidence-based decision-making tool that will provide a balanced view of the positive and negative health impacts of UPA.
13.	Lock & de Zeeuw (2000)	An overview of the main health risks associated with UPA was highlighted and mitigating measures were proposed	The health risks identified and the mitigating measures proposed were seen as working hypotheses that further research could be based on. The findings proposed a range of measures to mitigate the health risks identified under the following headings: (a) Mitigating diseases associated with the re-use of urban wastes and wastewater. (b) Developing environmental management programs for vector-borne diseases. (c) Mitigating the diseases associated with use of agrochemicals. (d) Measures to reduce spread of Zoonotic diseases.
14.	Mfoukou et al. (2001)	The aim is to describe the livestock component of UA in the city of Brazzaville, especially small ruminants. The urban breeder profile of the owners in the city was analyzed. A single visit multiple subject survey of 249 smallholders, holding 2190 small ruminants was used for the survey. Regression tree was used to obtain information on socio-economic parameters.	The study revealed more sheep are kept than goats in a pure flock or mixed flocks (ratio 1:9). Ave. size of the owner's flock was 8.78 heads (sheep & goats) which varies by nature of the herd and location. Constraints to production are both technical and non-technical. Concluded that small ruminant's production as a survival strategy for urban households may be seen as a reality in responding to crisis.
15.	Thys et al. (2005)	Objective of the study was to determine the importance of household ULP in Ouagadougou, determine the social profile of the livestock keepers and their motivations compared to that of other urban dwellers, to	Household heads keeping livestock and/or crop had larger household sizes, are older, usually males less educated and families live in town further away from uninvolved households compared to non-livestock keeping households. The study also found that income generation was one of the major motivations for keeping livestock, followed by food

		identify the major constraints related to ULP and the way livestock keepers are coping with them, and to determine the perception of the future of ULP by the livestock keepers. Survey questionnaire was used and 2008 households randomly selected. Face-to-face interview with household heads	provision plus revenue generation and home consumption. Other motivations include tradition; hobby and culture etc…A high percentage of all households surveyed attributed UPL as an essential strategy for survival for the household i.e. contributes to the well-being and/ or survival of the urban dwellers.
16.	Thys & Ekembe (1992)	To determine the importance of small ruminant rearing within this urban region. A survey of 542 compounds concerned with rearing and/or domestic slaughtering of small ruminants.	Households kept more flocks of sheep than goats about 8.71 times greater than the goat. Where a mixture of flocks are kept about 84% contained sheep only of the households sampled The Muslims kept more sheep than goats. Most breeders also raise the small ruminants for personal consumption Animals are kept indoor by those in the urban centres and allowed to move freely in the peri-urban areas The penned animals require more feed inputs while the free ones scavenge on wastes on the road sides and return to the compound at night. Total annual slaughter was 6 times greater than official figures Half of the slaughtering was for religious and festivities while the remaining half was slaughtered by professional butchers. The existence of a large population of sheep and goats in Maroua could be attributed to the importance of domestic slaughter for mainly Islamic, religious festivities. Another reason for this is the economy contribution of such activities because many breeders do not slaughter their own animals instead they sell them to the butchers and buy them from the market.
17.	Smith & Olaloku (1998)	To identify; (i) the importance and scope of UPA in the literature; (ii)The factors responsible for the rapid growth of the sector; (iii)The different production systems, constraints and opportunities to why the optimum performance or the potential economic returns are not achieved	Identified that technical, institutional and policy-related constraints are the major reasons why the optimum level of performance was not achieved in all the systems identified. The findings confirmed the study by Jansen (1992) and concluded that smallholder dairy production and processing in Nigeria near the urban areas in the 80s and 90s were not well established and needed some kind of intervention because of their economic contributions
18.	Speybroeck et al. (2004)	Study was aimed at the identification of location and household characteristics	Survey method, 2800 household families randomly selected. Non-Parametric (tree method CART) & Parametric techniques were

		influencing the choice of keeping livestock or practicing crop production in a post-conflict region in Central Africa.	compared. Results highlighted the shortcomings of using multinomial regression in studying urban farming. The use of classification tree information in a multinomial model was suggested as a useful tool for further analysis of livestock & crop production systems.
19.	Gabel (2001)	To explore the practical & strategic needs of urban farmers who occupy the role of provider within their households.	Research design based on feminist principles using ethno methodologies. Another method used was participatory approach (PRA). Strengths and weaknesses of participatory research were revealed. Despite net economic loss experienced by the women farmers, they received social and emotional benefits that have no dollar value. Key needs expressed by the women farmers are access to land as well as information needs around urban farming information
20.	Freeman (1993)	Identify the pattern of urban cultivation and the motivation of urban cultivators in the study area.	A survey of active cultivators was sampled and a two-level, clustered, spatial sampling frame was used to select 10 sample squares from a 50 square grid. Study suggests UA is not a stopgap activity, nor a means to become wealthy. Most common motivation for cultivation was the need to avert hunger and the availability of home grown food to free up scarce cash earned from off-farm jobs. Study also concluded that female cultivator face major impediments to meaningful advancement in large African city.
21.	Jansen (1992)	Household survey was conducted and data collected was used to investigate levels and patterns of dairy product consumption in northern Nigeria.	Data sorted out into income category, ethnic group and geographical location. Study revealed consumption levels and patterns of different households. The dairy products grouped into traditional and imported products. The per capita consumption average doubled that for Sub-Saharan Africa. Consumption also differed significantly from rural and urban households and between ethnic groups. Consumers preferred traditional dairy products as a result of their past experiences with high-input, large-scale dairy production which justify increased support for the development of traditional milk production systems and peri-urban dairy production and processing.

3.0 CHAPTER THREE: *THEORETICAL AND EMPIRICAL FRAMEWORKS*

3.1 Introduction

The main objective of this study is to assess perception of the major human and environmental health risks associated with livestock keeping in Kaduna metropolis. In the process of achieving this goal, various aspects and stages involved in human choice behaviour grouped into four specific objectives are identified which include: (i) determining socio-economic factors that influence livestock keeping in the study location; (ii) identifying human and environmental health risks associated with urban and peri-urban livestock keeping in the study location; (iii) assessment of attitudes and perceptions people have towards environmental and human health concerns associated with keeping of livestock; and (iv) determining the willingness-to-pay (WTP) for environmental intervention to reduce identified health risks associated with livestock keeping activities in the study location.

Based on the literature reviewed in the previous chapter, the conceptual model is formulated to illustrate the household's decision-making process as it relates to keeping of livestock and reduction of its associated health risk concerns. The conceptual framework used in addressing the above stated objectives is identified and based on the theory of human choice behaviour through a decision-making process. An attempt is made to conceptualize the entire household decision-making process using theoretical concepts from an economic perspective, and then test the conceptual model with empirical evidence drawn from a sample of both livestock and non-livestock keeping households within the metropolis of Kaduna state. The way chosen to achieve these specified study objectives and the possibility of empirically testing them was through a questionnaire/ survey. Different concepts and theories that are relevant in evaluating the survey data and in answering the research questions are presented.

Other theoretical considerations in this study are derived from established literature and include: random utility theory mostly used in discrete choice models, and cognitive psychology applied in psychological research in studying human behavior. These theoretical frameworks are considered based on their suitability to our study objectives.

The next section of this chapter is a brief review on the theoretical framework commonly used in decision-making and specification of discrete choice models.

3.2 Theoretical Framework

The theoretical framework section provides the structure for the study and theories supporting the study methodology. The study utilized the theory of decision making (section 3.2.1), utility theory for decision making (section 3.2.2) and theory of psychometric risk perception (section 3.2.3). The psychometric paradigm partly provided an assessment of the human and environmental health risks associated with livestock keeping as perceived by these households. The specified theories are therefore applied to achieve three of the core objectives of this study. For study objectives (i) and (iv), the random utility theory is applied in the choice models as specified in later sections of this chapter. In achieving objective (ii), descriptive statistics and factor analysis are used to identify various health concerns that could pose a risk associated with the decision made by households to keep livestock. The results from the exploratory factor analysis are then combined with other socioeconomic variables to run a multivariate regression analysis in achieving objective (iii).

3.2.1 Theory of Decision Making

This theory usually used in human problem solving procedure is based on how a 'rational' individual will make a decision by attempting to make an optimal choice. The theory has been largely applied in the fields of economics, social sciences and psychology in attempting to explain the behavior of an individual. This theory proposes that consumers make decisions based on the expected outcomes of their actions. In this model consumers are viewed as rational actors who are able to estimate the probabilistic outcomes of uncertain decisions and select the outcome which maximizes their well-being. The model is applied in the behavioral model (utility-maximizing behaviour) of households in making a decision to keep livestock or not.

The theoretical perspective under which models in the present study are built is based on the data collected from each individual household decision-maker. For instance, two states ‘A’ and ‘B’ are given as alternatives to an individual, a situation in which a choice has to be made. The individual may decide to choose either ‘A’ or ‘B’, choosing one in preference to the other. The application of the theory of decision-making basically focuses on how to predict the probability of such decisions made by individuals. The present study focuses on two decision-making processes that individual respondents faced in achieving study objectives (i) and (iv) and this will be discussed in later sections. An important research question here is what respondent characteristics determine the choice to keep livestock and WTP for health risk reductions. In the present study, three separate logistic regressions are specified to model household’s choice behaviour in achieving three of our stated objectives.

3.2.2 Utility Theory for Decision Making

3.2.2.1 Random Utility Theory and Discrete Choice Models

Discrete choice models concern such choice situations where a decision maker draws a choice from a non-empty set of mutually exclusive and collectively exhaustive alternatives and consumption of one or more commodities is required to be zero (Ben-Akiva and Lerman 1985). A discrete choice model is a way of presenting choice tasks to individuals in order to provide required information that can be used to elicit economic preference in a simplified dichotomous way. Utility is used to represent the relative attractiveness of the alternatives. Since alternatives do not produce utilities, they are therefore derived from characteristics of the alternatives and those of the individual as specified in Equation 3-6. The assumptions under which discrete choice models are applied assume that choices made by individuals can be predicted based on a limited set of quantifiable factors and that people are essentially rational decision-makers who seek to make choices that maximize their utility. Furthermore, the relationship between the underlying factors and the probability of the individual choosing a particular alternative is assumed to bear a particular functional form. The logit function is a common mathematical form used in discrete choice modeling. The model generally includes characteristics of the individual (e.g., age, gender, and income) and relative attributes of competing choices (e.g., price and type). It might also include environmental factors, personal attitudes, or factors which are thought to influence the choice in question.

3.2.2.2 Basis for Random Utility Model

Due to the uncertainty concerning the actual level of utility arising from a given alternative, a random component may be associated with the observed choices made by households (Ben-Akiva and Lerman 1985). The random component of the utility function therefore captures variations in choice due to within- and between-individual variance, omitted variables, measurement errors and imperfect information (Manski 1973). The need to apply probabilistic choice concepts, such as random utility models to explain behaviour in this present study becomes inevitable. Random utility models have been employed extensively in various studies (McFadden 1974; Ben-Akiva and Lerman 1985; Anderson et al. 1992) to postulate the highest (expected) utility associated with the choice made by a decision making individual or household when a set of alternatives are given.

The basic assumption embodied in the random utility approach to choice is that decision makers maximize utility, i.e., when a decision maker is given a set of alternatives, s/he will choose the alternative that maximizes his/her utility. The alternatives are normally represented as competing products, courses of action, or any other options or items over which choices must be made. The utility $U_{qi} = U(x_{qi}, s_q)$, of an alternative i for an individual q is represented as an unobserved random variable, which is assumed to consist of a systematic (or deterministic) component V and a random error term ε. Formally, this comparison for individual $q's$ utility of alternative i can be written as follows:

$$U_{qi} = V_{qi} + \varepsilon_{qi} \qquad (3.1),$$

where $V_{qi} = V(x_{qi}, s_q) \forall j$ is the indirect utility function associated with the observable attribute vector choice alternative i. In this representative utility function, some of the observable attributes of the alternatives as faced by the decision maker is labeled $x_{qi} \ \forall j$, and some attributes of the decision maker is labeled s_q. Hence the probability that individual q chooses alternative i from a particular choice set J, which comprises j alternatives, can be written as;

$$P_{qi} = P_r\left(U_{qi} \geq U_{qj} ; \forall \quad i \neq j \in J\right) \qquad (3.2),$$

$$P_{qi} = P_r\left(V_{qi} + \varepsilon_{qi} \geq V_{qj} + \varepsilon_{qj} ; \forall \quad i \neq j \in J\right) \qquad (3.3),$$

To transform this random utility model into an operational choice model, certain assumptions about the joint distribution of the vector of the random error terms are required. The random component is assumed to be independently and identically distributed (IID) according to a particular probability distribution (Ben-Akiva and Lerman 1985). A simple scaleable model where the choice probability of alternative i results in a function that shows only the differences in the two probabilities is presented below:

$$P_{qi} = P_r\left(U_{qi} > U_{qj} ; \forall \quad i \neq j \in J\right) = P_r\left(\varepsilon_{qj} < \varepsilon_{qi} + V_{qi} - V_{qj} ; \forall \quad i \neq j \in J\right) \qquad (3.4),$$

$$\left(V_{qi} - V_{qj} ; \forall \quad i \neq j \in J\right) \qquad (3.5),$$

V_{qi}, is assumed to have a linear form as shown in Equation 3.6:

$$V_{qi} = \beta' x_{qi} + \alpha_j' x_q + \varepsilon_{qi} \qquad (3.6),$$

where x_{qi} is matrix of attributes of the alternative i influencing choice experienced by the q^{th} household, β is a vector of coefficients for these attributes, x_q is a matrix of the individual-specific characteristics of the household that may influence the choice of i and α_j are vectors of coefficients of individual-specific characteristics for each of the j alternatives.

3.2.2.3 Adapting the Random Utility Theory to the Choice Model

In order to use the random utility model in this study to determine the probability that a respondent's household will choose to keep livestock, the discrete choice approach is applied. For the indirect utility function, the conventional approach of a linear specification where the individual subscript is suppressed was followed:

$$V_i = \beta_1 + \beta_2 Y + \beta_3 C + \beta_4 D + \beta_5 F + \varepsilon \qquad (3.7)$$

where V_i, is the indirect utility individual household derived by keeping livestock $(\ i = 1\ )$ or for not keeping $(\ i = 0\ )$. Y is the income category; C is a vector of personal characteristics that include socioeconomic and demographic characteristics that influence decision to keep livestock; D represents households' attitudes and beliefs for keeping livestock; F is the perceived risk associated with keeping of livestock; and β_i are the parameters of the model with $\beta_2\ \beta_3\ \ \beta_4\ \beta_5$ each representing vectors of parameters.

3.2.2.4 Binary Logit and Probit Estimation Models

The binary logit and probit models are two commonly used regressions in discrete choice models. While the logit model is the most widely used regression model, its derivation is based on the assumption that the distribution of the random error term is independently and identically distributed (IID) with extreme value for all chosen alternatives i (Ben-Akiva and Lerman 1985). This assumption tends to be restrictive and the critical part of this restriction is that the random error terms (i.e., unobserved factors) are assumed to be uncorrelated and have the same variance for all alternatives. Despite the restrictive condition of this model, it has provided a very convenient form for estimating choice probabilities. Based on the utility function in Equation 3.1, the choice probability for the binary logit model is usually specified in terms of event probability (Equations 3.8 and 3.9).

$$P_{iq} = \frac{1}{1 + \exp^{-\mu \beta x}} \qquad (3.8),$$

where μ is a scale parameter which is generally assumed to equal 1 and the choice probability is then given by;

$$P_{iq} = \frac{1}{1 + \exp^{-\mu \Delta V}} \qquad (3.9)$$

If we consider our model to be a binomial choice problem in which two vectors of independent variables, X and Y, defined our utilities (U_0, U_1), if the utility functions are given by (equations 3.10 and 3.11);

$$U_0 = \gamma_0 + \gamma_1 X_0 + \gamma_2 Y_0 + \varepsilon_0 \tag{3.10}$$

$$U_1 = \gamma_1 + \gamma_1 X_1 + \gamma_2 Y_1 + \varepsilon_1 \tag{3.11}$$

where γ is a parameter vector, X_i and Y_i are the vector values of the exogenous variables for the alternative i, and the ε_i's are the corresponding error terms (assumed i.i.d Gumbel). The binary logit model usually takes two forms, which can be expressed either in terms of the logit form or in terms of event probability (Liao, 1994).

3.2.3 Cognitive Psychology (Psychometric Paradigm)

Decision-making can be seen as a psychological construct used in a cognitive process, which is usually analyzed from different perspectives and in different contexts. A cognitive approach in decision making process is applied in this study following other authors that have used risk analysis as their theoretical perspective in risk perception studies. The main method considered in this study is the psychometric paradigm approach used in psychological research on risk perception (Bronfman and Cifuentes 2003; Slovic 1987; Slovic et al. 1981; Fischhoff et al. 1978). This approach has been discussed in full details in other sections of the preceding chapter.

3.3 Empirical Framework

In the present study model, certain variables were postulated as predictors of individual's attitudinal behaviour and perceptions of health risks. Based on findings from literature reviewed and discussions in earlier chapters, this guided the selection of relevant variables that could influence an individual decision-making process. The first model was developed to determine factors influencing individual household's choice of decision to keep livestock, putting certain socio-economic and demographic characteristics into consideration. The second model involves the assessment of an individual household's risk preferences captured as willingness-to-pay for environmental intervention that will reduce health and environmental risks associated with keeping of livestock. This is specified as a function of socioeconomic, demographic and general attitudinal risk variables.

3.3.1 Modeling socioeconomic determinants of household decision-making process and willingness-to-pay for health risk reductions

Research conducted in the area of household decision behaviour has primarily focused upon three critical issues: (1) which family member makes the decision, (2) outcomes of household decision behaviour, and (3) factors that determine which family member makes the decision (Qualls 1987). Decisions made by households may have large influences beyond the household boundary, and for this reason they are often of interest to Government and the public.

Prior studies on households' WTP suggest that household size, age, gender, number of children, educational attainment, income level and primary economic activity of households are more likely to influence individual household willingness-to-pay (Belete and Assefa 2003; Alberini et al. 2004; Morey et al. 2003). This study estimates the WTP for health risk reductions associated with livestock keeping activities and shows how these estimates vary dramatically across households as a function of respondent and household characteristics. Income effects can be incorporated into the model using available data on income category in a manner that is both simple and consistent with consumer theory. The choice of decision on WTP is modeled and estimated using a discrete choice random utility model that incorporates type of livestock kept and respondent characteristics and allows individuals in different income categories to have different marginal utilities of money (Morey et al. 2003).

Many discrete choice random utility models assume that WTP is not a function of income, that is, the marginal utility from expenditures on the numeraire is assumed to be a constant. In order to estimate a respondent household's WTP for the proposed environmental service, which measures in money and our expectation of the extent to which different households would gain or lose under this proposal. WTP model can be expressed as a function of income category. This income effect is usually introduced into such model by assuming the marginal utility of money to be a step-function of expenditures on the numeraire (Morey et al. 2003). This method of incorporating income effects is ideally suited for situations when exact income data is not available. Data on exact income has always proved difficult to obtain, and this is particularly true in the rural areas of developing countries where household production activities abound. Data are usually available on household wealth or standard of living (consumption pattern) but not on income. In this study, income category was not available households were categorized as middle or low income.

3.3.2 Choice of Socio-Demographic Variables Influencing Decision to Keep Livestock and Willingness-to-Pay for Health Risk Reductions

From previous studies, the most commonly specified variables identified as major determinants of the household decision-making process are: gender, age, educational status of respondent, household size and presence of children in the household, household location and income level (Thys and Ekembe 1992; Flynn et al. 1994; Egziabher 1996); Mfoukou et al. 2001; Quinn et al. 2003; Bawa et al. 2004; Nwafor 2004; Speybroeck et al. 2004; Thys et al. 2005).

From reviewed literature it is expected that people living in the rural or in the sub-urban fringes are more likely to keep livestock in their households because of their rural linkages. In most households in the study location, men are usually the head of household and therefore are the major decision makers. Men are expected to make the decision concerning the ownership and keeping of livestock in their household. They are expected to be more willing to pay than women for health risk reduction, since they generally earn more income and, furthermore, control the resources in the households in most cases.
It is generally hypothesized that male-headed households earn more income than female-headed households and that males control the expenses of the households in most cases.

Better-educated individuals are expected to be more knowledgeable than those with less education.

From previous studies on urban livestock keeping, we expect that older individuals are more likely to get involved in livestock keeping in their households and are expected to be more willing to pay for any services that will keep them in their vocation. Urban livestock keeping generates some form of income to this age group especially when they have retired from active employment or they might derive some form of social benefits from keeping livestock. From literature we also expect to see a greater proportion of respondents that are in the low-income households to be more likely to keep animals in their households as a means of livelihood strategy.

Married individuals are expected to be more likely to keep livestock in their households. In the same vein, they are also expected to be more willing to pay since they may derive nutritional benefits from keeping livestock to members of their household especially their children. Studies have also shown that larger household sizes are more likely to keep livestock in their neighborhood because of the available unpaid cheap family labour to take care of the animals and also to meet the household animal protein requirements. It is also expected that people with children in their households are more likely to keep animals and meet the animal protein requirements for these children. It is expected that people that live in and own their houses are more likely to own and keep livestock.

3.3.3 Choice of Variables for Attitudinal and Risk Perception Attributes

The personal knowledge and experience of risk individuals have in dealing with any form of risk are two major features that have been used to explain beliefs and attitudes of individual that are exposed to one form of hazard or another. Risk attributes have been used as factors to describe people's risk perceptions relating to activity, substance or technology that are risky to human and the environment. In this present study, six risk characteristics relating to human health and environmental concerns are used to assess people's perception of risk associated with livestock keeping activities. Factor analysis is applied to the qualitative responses from the scale items included in the survey questionnaire to reduce the set of items to a smaller set of dimensions. Detailed insights on how this analytical procedure was conducted and a discussion on the results are fully explained in chapter five. The variable "riskiness" was adopted as a proxy for assessing the overall perceived risk and this was hypothesized that those respondents who attributed high economic benefits derived from keeping livestock may tend to express low level of risk associated with such activity (the economic salience hypothesis). This implies that respondents who perceived less economic benefits from keeping livestock may tend to see the decision to keep livestock to be risky.

Furthermore, individuals who perceive they are in control of a particular hazard or risk are less likely to attribute risk to that situation. Such individuals are more likely to focus on positive aspects of their behaviour that can help to reduce risk, rather than focus on their own deficiencies or lack of control as noted by Strecher et al. (1986). However, those who perceived less control may be more unlikely to undertake such proactive measures. Therefore, it is expected that lower levels of perceived control would be associated with higher levels of perceived risk. From risk-analysis literature, it was asserted that risk perceptions are unevenly distributed across societies (Short 1984; Dosman et al. 2001). Studies have shown that individuals who have greater access to financial and educational resources tend to express higher tolerances for risk; while those with lower incomes and less education generally indicate lower risk tolerances for most hazard situations (Tomazic et al. 2002).

3.4 Chapter Summary

The general purpose of this chapter is to develop a predictive model of choice behaviour for a sample of households. However, this aggregate behaviour is proposed to be as a result of decisions made by individual households with regards to livestock keeping activities and their perceived risks associated with such livelihood activities in the study area. The conceptual model for this study is based on household's decision making process in keeping livestock in their various household locations.

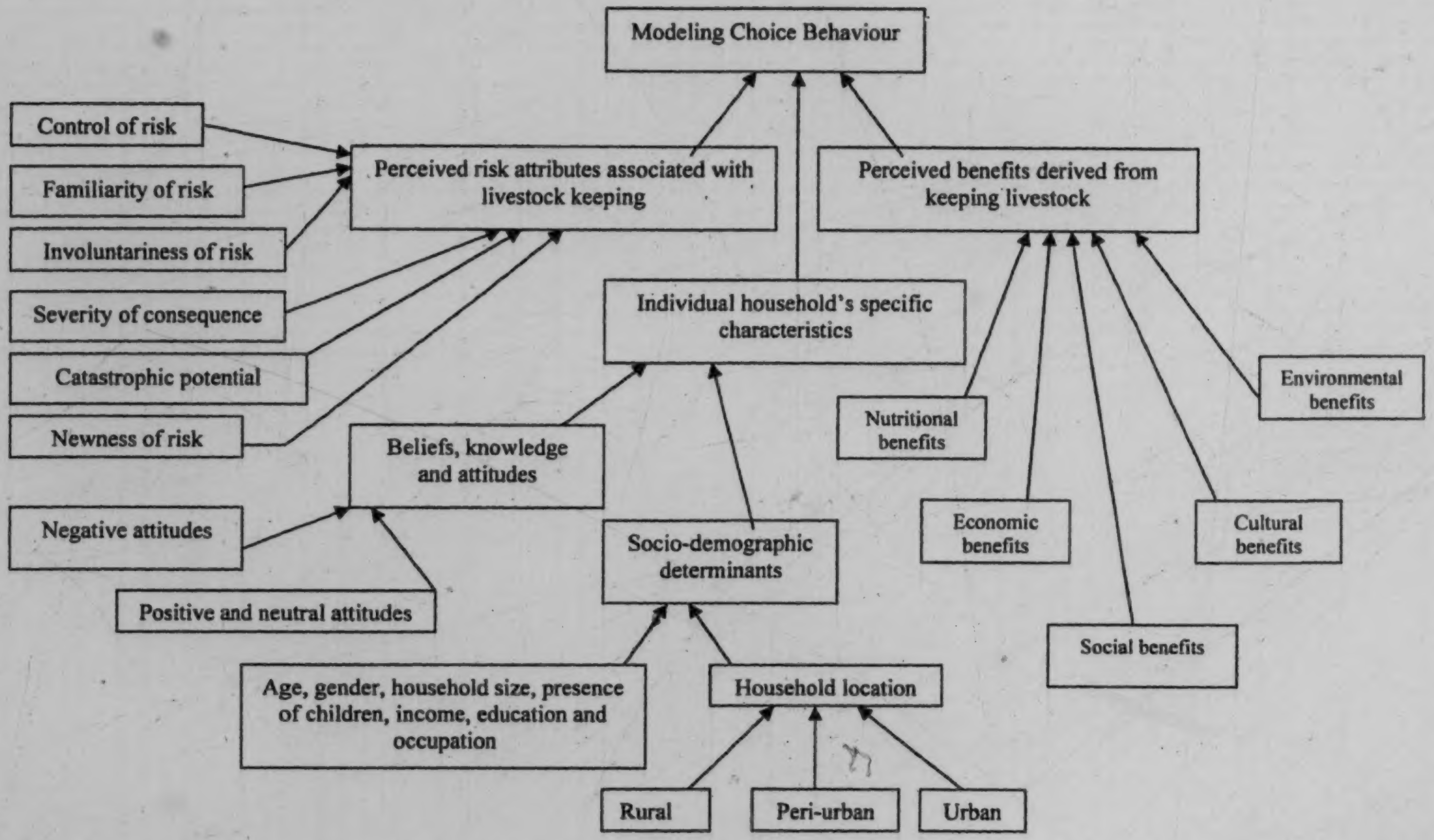

Modeling Choice Behaviour
Control of risk
Familiarity of risk
Involuntariness of risk
Severity of consequence
Catastrophic potential
Newness of risk
Perceived risk attributes associated with livestock keeping
Perceived benefits derived from keeping livestock
Individual household's specific characteristics
Beliefs, knowledge and attitudes
Negative attitudes
Positive and neutral attitudes
Socio-demographic determinants
Age, gender, household size, presence of children, income, education and occupation
Household location
Rural
Peri-urban
Urban
Nutritional benefits
Economic benefits
Social benefits
Cultural benefits
Environmental benefits

Figure 3-1: Conceptual Model of Household's Decision-Making Process in Keeping Livestock

4.0 CHAPTER FOUR: *SURVEY DESIGN AND METHODOLOGY*

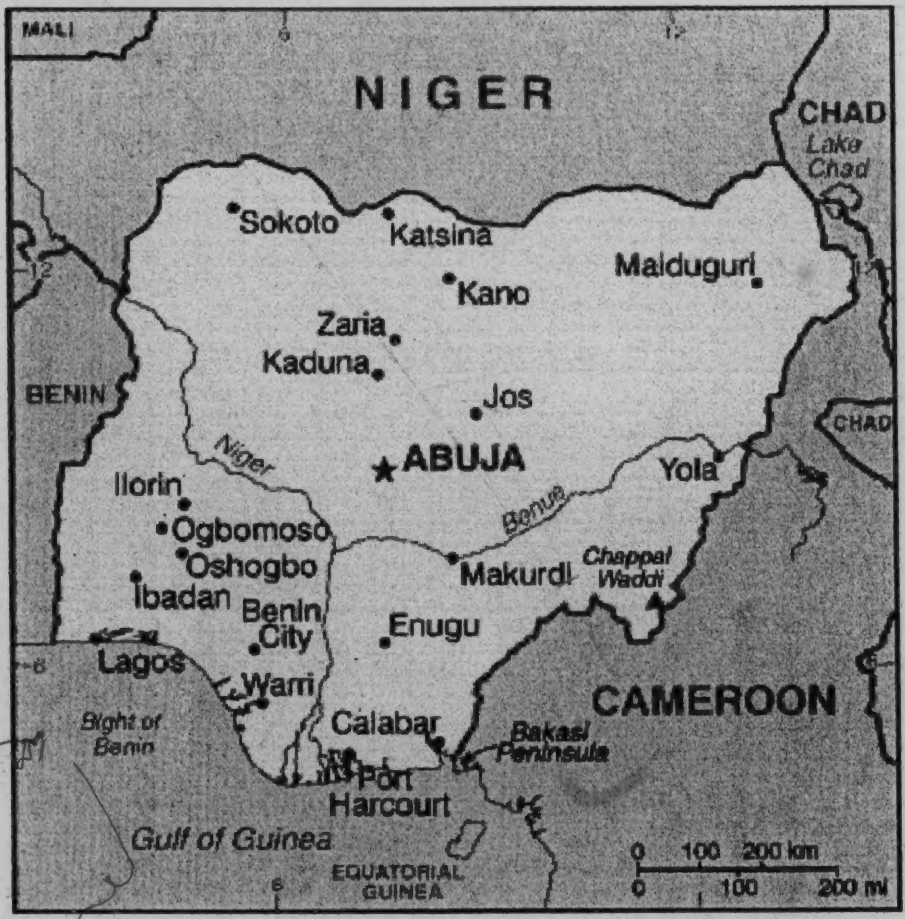
4.1 Introduction

The first section of chapter four is a brief description of the study area, including its demographic features and geographical location. This is followed by a discussion of the survey methods used which includes the sampling procedure, the data sources used for the study, the sample size selection, the criteria used for the selection of respondents and the survey instrument. The development of the survey instrument and its administration is highlighted and the purpose for using these techniques and their outcomes is also discussed in sections that follow.

4.2 Description of Study Area

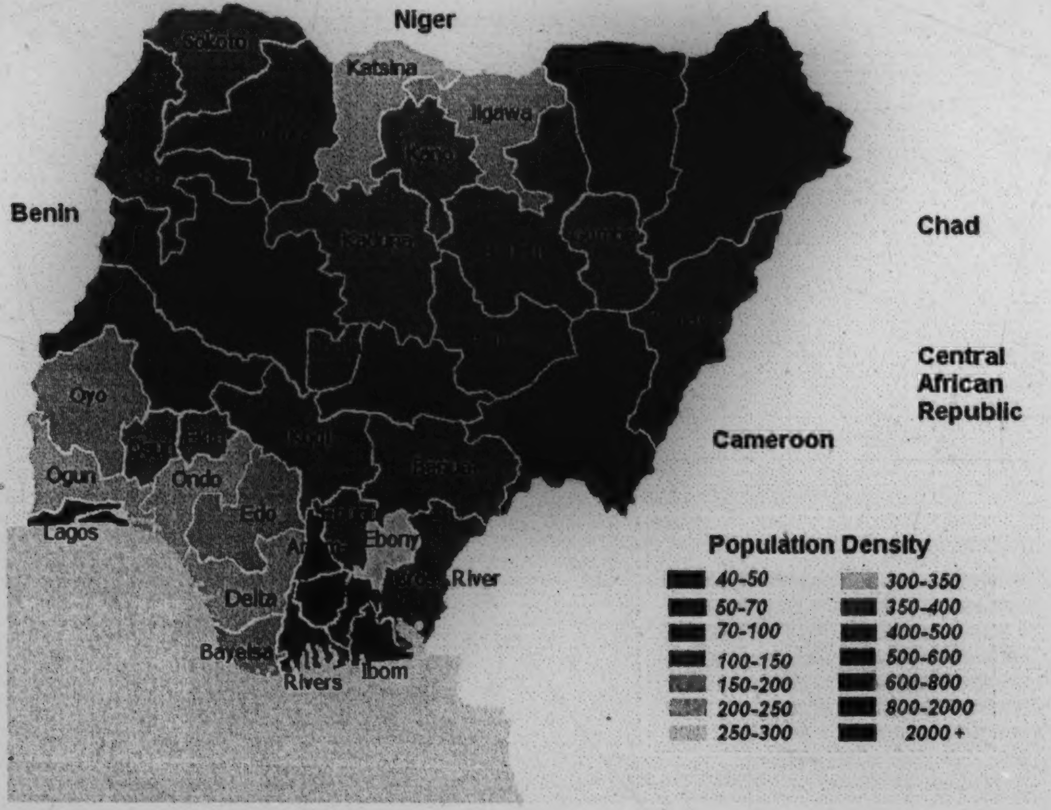
The study area is located in Kaduna State of Nigeria and lies within the sub-humid, Northern Guinea Savanna agro-ecological zone (AEZ) of the country where both domestic and commercial livestock production have been an instrument of socio-economic change to improve income and quality of life. The main criterion for selecting this location is based on the evidence from previous studies on the growing concerns and the rapidly expanding intensive and semi-intensive industrial and smallholder urban and peri-urban livestock keeping activities carried out in the state. As a result of the ecological location of the study area within the country, this will help to identify the human and environmental health problems associated with different levels of evolving urban and peri-urban livestock production systems in the state. Indeed, there exists a large number of studies that surveyed households involved in urban livestock keeping in the two major urban centers in the State (Gefu 1982; Bawa et al. 2004). In the current research study, however, both livestock and non-livestock keeping households will be targeted. In the study, there is an aim of getting householders' views on risk attitudes and perceptions of the various potential human and environmental health concerns associated with keeping livestock in their household and in the vicinity. The study will also include households located at the peri-urban areas as far as 25 kilometres from major urban centers. In Figure 4-1, the major cities of Nigeria, including the city of Kaduna, are portrayed, while Table 4-1 shows the twenty-three local government areas of the state.

Figure 4-1: Map of Nigeria Showing Major Cities


MALI
6
12
NIGER
CHAD
Lake Chad
Sokoto
Katsina
Kano
Maiduguri
Zaria
Kaduna
Jos
BENIN
CHAD
Niger
ABUJA
Yola
Ilorin
Benue
Ogbomoso
Oshogbo
Makurdi
Chappal Waddi
Ibadan
Benin City
Enugu
Lagos
Warri
CAMEROON
Bight of Benin
Calabar
Bakasi Peninsula
Port Harcourt
Gulf of Guinea
EQUATORIAL GUINEA
0 100 200 km
0 100 200 mi

Source: CIA World Fact Book (2007)

Figure 4-2: Map of Nigerian States by Population Density


Niger
Sokoto
Katsina
Jigawa
Kano
Kaduna
Benin
Chad
Central
African
Republic
Cameroon
Oyo
Osun
Ekiti
Kogi
Ogun
Ondo
Edo
Benue
Lagos
Anambra
Ebonyi
Cross River
Delta
Bayelsa
Rivers
Ibom
Population Density
40-50
50-70
70-100
100-150
150-200
200-250
250-300
300-350
350-400
400-500
500-600
600-800
800-2000
2000 +

Source: http://en.wikipedia.org/wiki/List_of_Nigerian_states_by_population ; Web page, [accessed 19 July 2007]

Table 4-1: Local Government Areas (LGA's) in Kaduna State

S/N	LGA	HEADQUATERS
1.	Birnin-Gwari	Birnin-Gwari
2.	Chikun	Kujama
3.	Giwa	Giwa
4.	Igabi	Turunku
5.	Ikara	Ikara
6.	Jaba	Kwoi
7.	Jama'a	Kafanchan
8.	Kachia	Kachia
9.	Kaduna North	Magajin-Gari
10.	Kaduna South	Makera
11.	Kagarko	Kagarko
12.	Kajuru	Kajuru
13.	Kaura	Kaura
14.	Kauru	Kauru
15.	Kubau	Anchau
16.	Kudan	Hunkuyi
17.	Lere	Saminaka
18.	Makarfi	Makarfi
19.	Sabon-Gari	Dogarawa
20.	Sanga	Gwantu
21.	Soba	Soba
22.	Zango-Kataf	Zonkwa
23.	Zaria	Zaria

Source: From the local government headquarters

4.2.1 Demography

The State of Kaduna is located in the central part of Northern Nigeria with a size of about 46,053 square kilometres and a population of about 5,001,258 based on the 1991 census but a 2005 estimate showed a population of 4,849,075 (Anonymous). The population density is about 700 people per square kilometre. Although the number of ethnic groups is much larger, the main ethnic groups are Bajju, Kataf, Kagoro, Moro'a Jaba, Gbaggyi, Kanninkon, Ninzam, Hausa Fulani, Chawai, Hurama, with Hausa and English languages widely spoken. Although the majority of these ethnic groups live and depend on the rural areas, one-third of the State's population is located in the two major urban centres of Kaduna and Zaria. The population concentration in these major urban centres is moderate reaching more than 500 persons per square kilometre. In the neighbouring villages like

Jaba, Igabi and Giwa the population density is about 350 persons per square kilometer whereas it is 200 persons per square kilometre in Ikara LGAs (Anonymous).

4.2.2 Geography

Kaduna State shares borders with Sokoto, Katsina, Niger, Kano, Bauchi and Plateau States and also with the Federal Capital Territory Abuja. The State is located globally between latitude 6° 09' and 11° 30' N of the equator, while the state capital lies on the latitude 10° 31' 23N and longitude 7° 26' 25E (Falling rain Genomics, Inc. 1996-2004). There are two marked seasons in the state: the dry windy season and the rainy season. The agro-ecological zone where the state is located has an annual rainfall ranging from 600 to 1000mm. There is heavy rainfall in the southern parts of the state like Kafanchan with an average rainfall of about 1016mm while the state as a whole experiences a rainy season of about five (5) months from April to October. Kaduna State extends from the tropical grassland known as the Guinea Savannah to the Sudan Savannah in the north with about 80 percent of its population engaged in peasant farming producing both food and cash crops, the production of which is through the traditional method. Major crops produced in Kaduna State include cotton, groundnut, tobacco, beans, maize, yam, guinea corn, millet, ginger, rice, cassava, tomato, sugarcane, shea nuts, cowpea, mango, kenaf, cocoyam, sorghum, timber, palm kernel, banana, soybean, onions, corn and potatoes. Another important agricultural activity that people in the state are engaged in is animal rearing and animals usually kept include cattle, sheep, goat, pigs and poultry.

4.2.3 Overview of Livestock Keeping in Kaduna State

Livestock keeping are still practiced on a small scale in the state. The main purpose of keeping them is to raise cash during emergencies or to meet demands during religious festivals. Based on the 1991 livestock survey in urban Zaria and its rural fringe alone, there were over 16,000 head of cattle (zebu), about 180,000 goats, 138,000 sheep and rams, 10,000 pigs, 55,000 rabbits and over 880,000 birds (the poultry are mainly chickens, kept in commercial farm pens and on traditional free-range in compounds). In the southern parts of the state, pig rearing is dominant and the number of pigs in the area is not known. However, considering the urban livestock surveys in Zaria and Kaduna in

1991, most of the pigs are kept and owned by people from Jama'a, Sanga, Zango-Kataf, Jaba, Kachia and Kagarko local government areas.

4.3 Design of the Survey Instrument

The questionnaire was designed to cover the main aspects of the study involving the household behavioural decision to keep livestock and willingness to pay for health risk reductions associated with such activity, and its conception was based on an extensive review of scientific and professional publications about evolving livestock production systems and its attendant problems. A cross-sectional survey method was used to gather information from each individual household sampled from various study locations identified to be keeping one form of livestock in their households. The baseline field survey was carried out in six local government areas of the State where major urban and peri-urban livestock keeping households have been identified in previous studies and following a pre-test of the survey instrument. The wide coverage was done to eliminate any form of bias in the survey and to include households from minority groups based on religious and ethnic differences.

4.3.1 Sampling Procedure and Sample Size Selection

The total population size for this study is unknown since there are no documented figures for the number of people keeping livestock and living in the selected locations. Therefore, it was assumed that the sample taken is from an infinite population. Using a simple random sampling procedure (method) to select the required sample might not be the most statistically efficient method of sampling in our study survey. A stratified sampling approach that involves dividing the whole State into strata by local government areas was used. Households were chosen from six (6) local government areas by purposive sampling[9] based on the metropolitan location of that household within the strata (Table 4-2). Then a *disproportionate* stratified random sampling[10] was applied by specifying different sampling fractions in the strata to achieve a meaningful sampling with less variance. The sampling frame consisted of a list of all the local government areas located in the state. Sample stratification for the drawn sample was achieved with respect to the following two characteristics: (1) the location of the household if it is in the urban, peri-urban or rural area; and (2) livestock keeping versus non-livestock keeping households in the location.

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[9] The word purposive was used in our sampling technique to restrict the sample population to a very specific population (livestock keeping population) and then tends to use all of the subjects available for the study purpose.

[10] Disproportionate stratified random sampling is a form of probability sampling used to sample populations stratified by high concentrations in one geographic location or sampling frame usually from a rare population within a stratum (Gibson and Herzog 1984). Rare populations are small subsets of the

The sample size for the survey was determined based on the state's average household keeping livestock and the coverage area. This also depends on the range of variables to be investigated, the desired level of precision, confidence levels, the degree of sample variability and the estimated proportion of households to be sampled. The variability of variables for this target population was unknown, since there are no previous studies of this nature that can be used to establish the population standard deviation. The population size in this study is therefore assumed to be infinite and a maximum variability of ($p = 0.5$) is also assumed.

Table 4-2: Selection of the Primary Sampling Unit (PSU) from each Local Government Area

Selected Local Government Areas (Domain)	Metropolitan Location (PSU)		
	Rural area	Peri-urban area	Urban area
Chikun		Ungwar-Sunday Sabon-Tasha	Narayi Barnawa
Giwa	Giwa Gangara Shika		
Kaduna North		Mando-Kawo	
Kaduna South			Angwa-Rimi
Sabon-Gari		Samaru	Sabon-gari Hanwa (GRA)
Zaria		Tudun-wada Tudun-jukun Wusasa	Gaskiya Kongo

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general population-too small in probability samples to allow for multivariate analyses (Gibson and Herzog 1984; Kalton and Anderson 1986).

4.3.2 Survey Techniques

Both formal and informal survey interview methods were employed to gather necessary information required for the study. The informal survey was conducted at the study site to pre-test the survey instrument before the actual field survey was initiated. This involved interviews with key informants and identification of households to include in the sample, to elicit their views on livestock keeping close to where people live and what they perceive as potential health concerns associated with such activities in the area. The objective of this informal survey was to familiarize the respondents with the purpose of the study. This also helped the researcher to identify some major health concerns associated with livestock keeping in the study location that were not listed initially in the questionnaire, an attempt to incorporate these further identified variables in the survey instrument by rephrasing the questions. The 'key informants' included those working with the Federal Ministry of Agriculture at the National Livestock Project Department (NLPD) in the State and the Kaduna State Ministry of Agriculture's Veterinary Department.

4.3.3 Survey Administration

The formal field survey was conducted to collect primary data. The survey was conducted over a period of three months from December 2005 to February 2006. The survey interviews were cross-sectional based on in-person interviews. At the initial stage of the survey, 315 households were selected and notified about the survey and approached for their consent; only 309 households fully participated and completed the survey. Fifty-one (51) survey interviews were conducted at three districts (Giwa, Gangara and Shika) in Giwa local government area. This location is primarily a rural setting and the purpose of sampling households in the area was to ensure some degree of representativeness of respondents with different socio-economic characteristics, ethnic groupings and metropolitan location. This also helped to make necessary modifications to the survey instrument based on the level of understanding of these respondents by rewording some of the questions during questionnaire administration. This also served as a basis for study comparison with those respondents from urban and peri-urban household locations.

The survey instrument was drafted in a way to acquire both qualitative and quantitative information through which tests of hypotheses could be formulated. The information contained in the questionnaire was developed in line with proposed objectives and the theoretical dimensions of using a discrete choice model. Information was also sought on risk attitudes and perceptions of households toward health concerns associated with livestock keeping to humans and the environment. Further modifications of the instrument were based on the information gathered during the informal interviews with respondents and other key informants.

There are five main sections in the questionnaire (see Appendix A4). The first section was a brief introductory note of the study and the researcher, the study location and identification number. The second section was designed to acquire information on livestock keeping activities of respondents. The third section addresses the general risk attitudes of respondents and the information gathered from this section were more of attitudinal responses/views of study subjects on health concerns. The fourth section provides information from single-bound discrete choice (DC) contingent valuation (CV) questions and the final section was designed to provide information on general socio-economic and demographic characteristics of the respondent's household. The information included in this part of the survey instrument was based on findings from previous studies on socio-economic parameters that influenced professional activities of household members (Mfoukou et al. 2001).

4.3.5 Sampling Methods

The overall objective of this study is to qualitatively characterize and assess the potential human and environmental health risks associated with urban and peri-urban livestock keeping in Kaduna metropolis. Sample selection was carried out purposively to include both livestock and non-livestock keeping households. Sampling was achieved based on selection of households located in different metropolitan locations from six (6) local government areas of the State. The two major urban centers are Zaria (located in Zaria local government) and Kaduna (separated into Kaduna North and South local government areas). Giwa and Sabon-gari local government areas are identified as two locations close to Zaria urban centre and where livestock keeping are also predominant among the settlers. Chikun local government area was also included in the sample selection due to the location proximity to Kaduna metropolis and evidence of high population of households keeping livestock.

The sample was stratified by local government area and from each location a purposive selection of households based on the size of the metropolitan locations was used for the final selection (10-20 respondents in peri-urban location and 20-40 respondents in an urban location). This method is efficient for controlling the sample size in terms of number of households selected and has the advantage of concentrating the sample in the larger primary sampling units, which reduces the data collection cost.

4.4 Contingent Valuation Techniques for the Willingness-To-Pay (WTP) Questions

The following section briefly outlines the valuation questions. The contingent market concerned respondents WTP via a hypothetical weekly fee being charged by the city authority to provide basic environmental services such as garbage pick-up, wastewater treatment or disposal of livestock waste. Because of lack of previous valuation estimates to support the definition of a dichotomous choice bid vector, the contingent market employed an open-ended WTP valuation mechanism [willingness-to-pay: yes (1) or no (0)], followed by an open-ended question to elicit the spontaneous WTP of each individual household (Akpalu 2000; Alberini and Cooper 2000). The valuation mechanism was introduced to respondents via the provision of two hypothetical situations relating to livestock wastes (manure) produced as result of livestock keeping activity in the vicinity. The relevant payment vehicle was introduced to households via a discrete responses payment principle question. Households which responded positively to the payment principle question were then asked about their maximum WTP to provide the proposed service. Additional questions relating to their socio-economic characteristics, income-level and livestock keeping activities are sorted for. Further details and the full text of the two scenarios are provided in Appendix A4 in the sample survey questionnaire.

4.5 Chapter Summary

A brief description of the study area highlighting the demographic and geographic information precedes the other sections that centrally focused on the survey design and methodology adopted. In this chapter, the stages involved in designing the survey material and methodology for collecting primary data from sampled households are demonstrated. The sampling techniques used and the selection of the sample size are also highlighted. In the last section of this chapter a brief explanation of the contingent valuation techniques are addressed in the willingness-to-pay questions and how the hypothetical market scenarios were introduced to the households.

Table 4-1: *Sample of Studies that used Survey Questionnaire to Study Urban Agriculture*

No.	Author/Year/title	Information on sampling method used, questionnaire structure and tool of analysis
1.	Jansen (1992): Dairy consumption in Northern Nigeria: Implications for development policies	Household survey to investigate levels and patterns of dairy product consumption in northern Nigeria
2.	Lanjouw, Quizon, and Sparrow (2001): Non-agricultural earnings in peri-urban areas of Tanzania: evidence from household survey data	Uses purposive random sampling technique of approximately 600 households in peri-urban Tanzania to describe the degree and nature of non-farm diversification in these settings
3.	Murphy and Tisdell (1996): Village livestock and disease control in Northern Thailand: a survey examining socio-economic factors	Conducted a survey of 135 village households in Northern Thailand owning livestock to determine the socio-economic characteristics of the households specified in the study.
4.	Quinn et al. (2003): Local perceptions of risk to livelihood in semi-arid Tanzania	Examines variation in local perceptions of risk in semi-arid Tanzania by identifying factors that influence local perceptions of problems and testing the feasibility of risk mapping as a technique. Risk questionnaire was used to elicit information from villagers about their concerns and worries in providing means of livelihood for themselves and their families. Responses grouped into 212 categories of problem and incidence and severity indices were calculated for each category.
5.	Adesehinwa, Okunola, and Adewunmi (2004): Socio-economic characteristics of ruminant livestock farmers and their production constraints in some parts of south-western Nigeria	Face-to-face interview using questionnaire administered to 500 farmers randomly selected from two local government areas (LGA's) located in two south-western states in Nigeria. Five villages out of 30 villages on the map were selected from one of the LGA's and 5 villages selected out of the 35 villages in the other. Villages were further divided into 4 wards out of which 2 wards were randomly selected. Twenty-five farmers were interviewed per ward.
6.	Thys et al. (2005): Socio-economic determinants of urban household livestock keeping in semi-arid Western Africa	The study made use of survey questionnaire to document the socio-economic determinants of urban livestock keeping in a semi-arid environment, its constraints and the underlying driving forces for keeping livestock in the city and the perception of the future by

		livestock keepers.
7.	Ajala and Gefu (2003): Socio-economic factors influencing small-ruminant management practices in Kaduna State (Nigeria)	120 questionnaires administered to randomly selected small-ruminant farmers in Giwa LGA in Kaduna state. Descriptive statistics and Pearson's correlation and stepwise regression were used as tools of analysis.
8.	Gefu (1992): Part-time farming as an urban survival strategy: a Nigerian case study	Rapid assessment survey was used to determine the level of involvement, motivating factors and the general perception on part-time farming. A short questionnaire was distributed to 550 academic and non-academic staff members of the Ahmadu Bello University, Zaria, Nigeria.
9.	Mfoukou et al. (2001): Small Ruminant as a Survival Strategy for Urban households in the city of Brazzaville, Congo: A reality?	Single visit multiple subject survey on urban ruminant production. 249 urban smallholders holding 2,190 small ruminants were involved in the survey. Seven urban districts were selected and 249 respondents were categorized into five categorical variables and used as the dependent variable based on their profession or activity groups they belong to.
10.	Richardson and Whitney (1995): Goats and garbage in Khartoum, Sudan: a study of urban ecology of animal keeping	The paper identifies waste management in developing urban areas as an acute problem. Survey of 319 households in Greater Khartoum was conducted to estimate waste intake per urban animal and their demographic factors such as rural or urban, income, education and number of children as some of the factors that influence animal keeping. A Log linear/logit model was used to predict animal-keeping households.
11.	Okuthe et al. (2003): Use of rapid rural appraisal and cross-sectional studies in the assessment in smallholder cattle production systems in the western Kenya highlands	Both qualitative and quantitative epidemiological methods were used. Rapid Rural Participation was used to collect data from the rural and peri-urban areas. Cross-sectional survey data was collected (quantitative) from a random sample of farms in the study area.

5.0 CHAPTER FIVE: *ANALYSIS OF THE SURVEY DATA SET*

5.1 Introduction

This chapter includes the statistical evaluation of the survey data which are presented in text, table and diagram forms. Summary statistics of some selected socio-economic and demographic parameters measured are presented in form of frequency counts, percentages and contingency tables. Detailed explanations of each variable are given in the sections that follow. Principal components factor analysis was conducted to reduce the question (scale) items on risk perception characteristics to a smaller set of dimensions. The PCA was used to select a subset of variables from the larger set of scale items that have the highest correlations with the principal component factors. Coefficients of variation and chi-square tests were conducted on some of these variables to estimate their association and statistical significance for inclusion in further analysis.

In order to answer the research objectives stated and complete the study objectives, for the first objective, respondents' characteristics are analyzed which include socio-demographic information, such as location of household, type and number of livestock kept, ownership of the livestock, reason for keeping, gender, age, respondents' educational attainment, household size, marital status and number of children in the household. Along with this type of information, respondents were asked to identify some health concerns associated with keeping of livestock, as well as their attitudes and perceptions towards such concerns. Question on willingness to pay (WTP) for reduction of such health risks are elicited via the dichotomous choice contingent valuation method. Considering factors that could influence respondents to keep livestock in their households and their WTP for reductions of identified health risks, the study analysis is based on assumption of some economic principles that is further applied in the behavioural models.

A series of bivariate and multivariate analyses were performed on the data using SPSS version 15.0 for Windows. Conventional significance levels (i.e., *p*_.05) were used to determine significance in bivariate analyses, which in turn employed a variety of parametric and non-parametric tests of association selected on the basis of appropriateness to the level of measurement. Multivariate analyses were conducted using logistic regression given that the outcome variables of interest were dichotomous and the potential explanatory factors were a mix of categorical and continuous variables. The goodness of fit of the logistic regression models was assessed using the rho-squared statistic. A rho-squared value of 0.20-0.40 is considered a good fit of the model (Wrigley 1985).

5.2 Descriptive Analysis of Data Set

The descriptive statistics for the survey data given in this section are based on a cross-sectional survey in which a total of 315 households were initially identified for the survey. Of these 315 households, 309 household respondents completed the relevant parts of the questionnaire. Sampled households were located in seventeen (17) identified enumeration areas and three of these areas were located in three districts in Giwa local government area, a rural setting. Table 5-1 shows a general summary of the sample survey characteristics when compared with the national census-based demographic data of Nigeria versus that of Canada population. Table 5-2 shows the percentage distribution of households selected in our study by household location and enumeration area and Table 5-3 is the summary statistics of some selected socioeconomic and demographic characteristics of respondents in the sample. Figure 5-1 presents the percentage metropolitan distribution of all households selected for the survey by household location. All fifty-one (51) respondents from the rural location keep livestock in their households and this confirms the argument that keeping of livestock can be linked to rural settings.

Table 5-1: Comparison of Sample Survey Characteristics versus Census-based Demographic Data of Nigeria and Canada Population

Socioeconomic and Demographic Characteristics	Representation in the Survey Sample	Nigeria[11]	Canada
% Female (15-64 years)	n/a	26.87%	34.41
% Household with 4 or more children	76%	n/a	n/a
Median age (2007 est.)	n/a	18.7 years	39.1 years
% Bachelor's degree or higher	56.7%	n/a	n/a
Median income	n/a	n/a	$49, 411
65 years and over	4.9%[12]	3.1%	13.5%

Demographic Characteristics	Kaduna	Nigeria	Edmonton	Alberta	Canada
Size (land area) (km^2)	46,053	923,768	9,817.88	661,848	9,984,670
Total Population	4,849,075 (2005 est.) 6,066,562 (2006 census figure)	135,031,164 (CIA-July 2007 est.) 140,003,542 (2006 census) Not approved	1,034,945	3,455,062 (2007 est.)	32,989,100 (2007 est.) 33,390,141 (July 2007 est.)
Metropolitan population density (km^2)	700 people	145 people	109.9 people	5.38 people	3.2 people

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[11] CIA – The World Factbook – Guide to Country Profiles (2007)

[12] Sample survey is 65 years and over

Figure 5-1: Distribution of Households Surveyed by Metropolitan Location

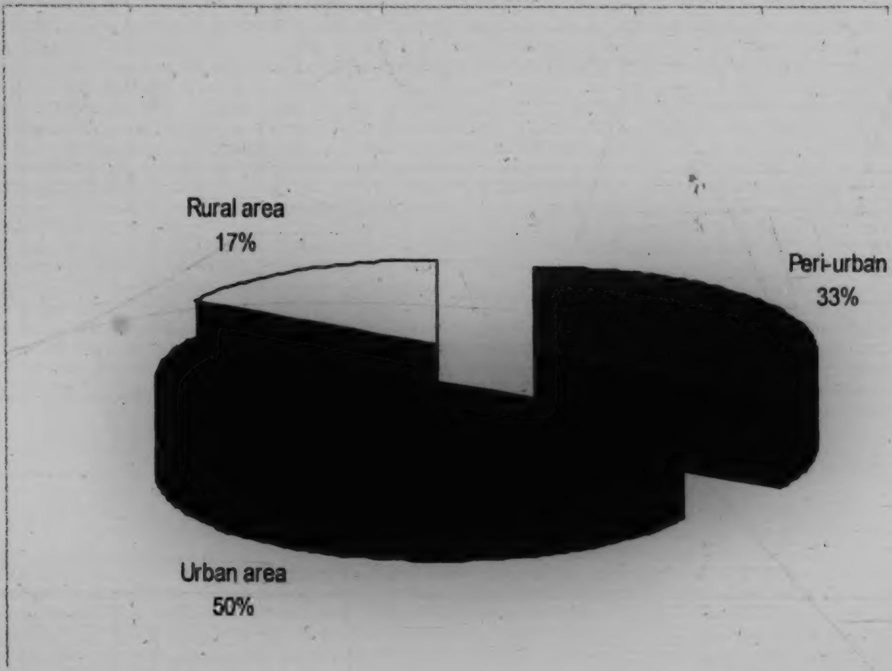

Table 5-2: Percentage Distribution of Selected Households by Location and Enumeration Area

Enumeration area	Household Location			Total
	Rural area	Peri-urban area	Urban area	
Giwa	15			15
Gangara	15			15
Shika	21			21
Kongo			20	20
Gaskiya			20	20
Sabon-gari			20	20
Samaru		10		10
Hanwa (GRA)			10	10
Tudun-jukun		20		20
Wusasa		20		20
Tudun-wada		20		20
Sabon-Tasha/Angwa-Sunday		17		17
Barnawa			21	21
Narayi			47	47
Angwa-Rimi			17	17
Mando-Kawo		16		16
#	51	103	155	309
%	16.5	33.33	50.16	100

Source: Field Survey, December 2005-February 2006

Table 5-3: Summary Statistics of Selected Socioeconomic and Demographic Characteristics of Respondents in the Data Set

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Dev
Educational Level	298	1	5	3.03	1.06
Gender	309	1	2	1.38	0.49
Age category	302	1	5	2.45	1.08
Household Size	283	1	4	2.48	1.14
Years Lived in Community	290	1	4	2.18	0.50
Ownership of House	303	1	3	1.64	0.70
Employment Status	290	1	4	2.21	0.89
Marital Status	298	1	4	1.66	0.65
Household Location	309	1	3	2.34	0.75
Livestock Housing	228	1	7	4.39	2.00
Ownership of Livestock	241	1	5	1.91	1.14
Number of Children	298	1	7	4.38	2.18
Number of Poultry Kept	182	1	4500	86.14	382.45
Number of Sheep Kept	95	1	55	8.57	8.49
Number of Goat Kept	107	1	100	8.46	10.99
Number of Pigs Kept	24	1	30	7.13	6.94
Number of Rabbit Kept	15	2	50	10.4	11.53
Number of Cattle Kept	35	1	76	7	14.52
Number of Others Kept	17	1	15	6.76	4.55

Source: Field Survey, December 2005-February 2006

5.2.1 Gender

In this current study's sample, the respondents included 193 males and 116 females (Table 5-4). Twenty-nine of the male respondents are located in the rural area while 62 and 102 male respondents were located in peri-urban and urban areas respectively. Of the 116 female respondents, 22 were located in the rural area while 41 and 53 female respondents were in peri-urban and urban areas respectively. In the rural, peri-urban and urban locations female respondents that reported keeping livestock are 22, 32 and 38 respectively while only 9 and 15 female respondents in the peri-urban and urban areas reported not keeping livestock. Out of the 29, 62 and 102 male respondents in the same locations, 29, 49 and 79 reported keeping one form of livestock or another in their households respectively, especially ruminants and poultry while 13 and 23 male respondents in the peri-urban and urban areas respectively reported not keeping livestock. The average age of respondents' in all locations falls within two age categories of 25-34 years and 35-44 years, which implies the mean age of the sample respondents, is approximately 34.5years[13]

Table 5-4: Frequency Distribution of Households Keeping Livestock by Location and Gender

Household keeping livestock	**Household Location**	**Gender**		**Total**
		Male (%)	Female (%)	
Yes, keep	Rural area	29	22	51
	Peri-urban area	49	32	81
	Urban area	79	38	117
	Total	157 (63)	92 (37)	249
No, do not keep	Peri-urban area	13	9	22
	Urban area	23	15	38
	Total	36 (60)	24 (40)	60

Source: Field Survey, December 2005-February 2006

5.2.2 Age category

The descriptive result of this variable is confined to five age groups. Comparing the age category of respondents, the descriptive statistics within the five age strata show that more than 20 percent of respondents are less than 25 yrs in age, 35 and 27 percent of respondents fall within the 25-34 yrs and 35-44 yrs respectively. In the age categories 45-54 yrs and 55 yrs above, about 13 and 4 percent of all the respondents fall into these categories respectively. A cross tabulation of respondents keeping livestock (Table 5-5) indicates that approximately 19 percent (46 respondents) that keep livestock are in the lower age group while two-thirds of respondents (approximately 63%) that keep livestock in their households fall into the sample average age category (approximately 34.5years).

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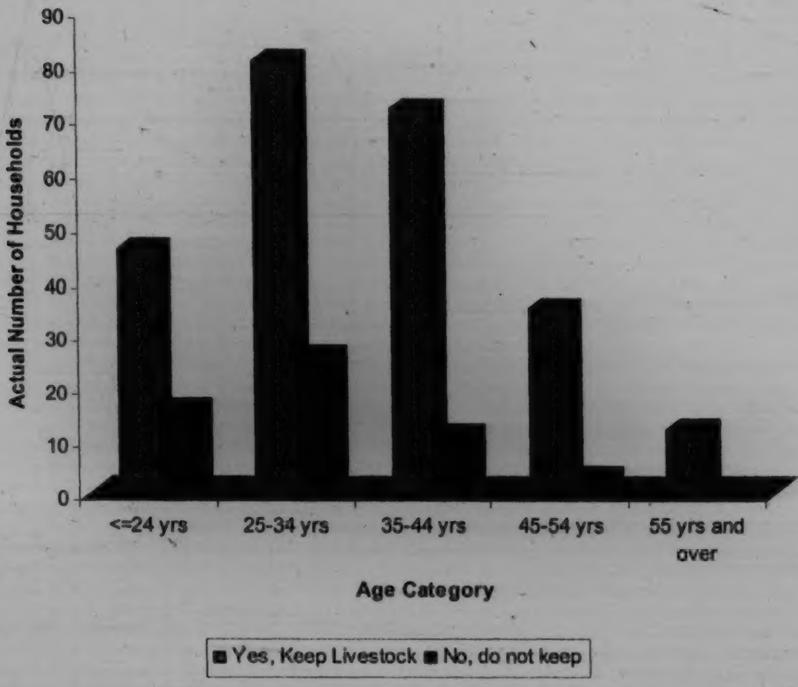
[13] The sample distribution by age category in Table 5-6 shows that the 25-34 yrs age category has the highest percentage (35%) of respondents followed closely by 35-44 yrs age category (27%). But the descriptive analysis shows that the mean age category is 2.45 and since we have 5 age categories, this implies that the mean age definitely falls within age category 2 and 3. Therefore, taking the average of the extreme values for these two age categories gives an approximate sample mean age of 34.5 years.

Table 5-5: Frequency Distribution of Households Keeping Livestock by Age Categories of Respondents

Age category	Household keeping livestock		Total
	Yes, keep livestock	No, do not keep	
<=24yrs	46 (18.8%)	16 (28.1%)	62 (20.5%)
25-34yrs	81 (33.1%)	26 (45.6%)	107 (35.4%)
35-44yrs	72 (29.4%)	11 (19.3%)	82 (27.2%)
45-54yrs	35 (14.3%)	3 (5.3%)	38 (12.6%)
55yrs and over	12 (4.9%)	1 (1.8%)	13 (4.3%)
Total	245	57	302

Source: Field Survey, December 2005-February 2006

Figure 5-2: Livestock Keeping by Respondent's Age Category



5.2.3 Marital Status

Of the 309 respondents surveyed, 298 responded to the question on their marital status (Table 5-6). One hundred and twenty four (42%) of the 298 respondents indicate they were never married; 158 (53%) respondents are married while very small percentages are either divorced/separated (3.02%) or widowed/widower (2.4%). Ninety five (95) of the respondents that keep livestock in all locations are either single or never married. One hundred and thirty-seven (137) of the respondents are married people and they also keep livestock in their households which implies about 57 percent of the 249 respondents that keep livestock are married people. Of the 5 percent respondents that are either divorced/separated or widowed/widower, only thirteen (13) of these respondents keep livestock which is about 4 percent of the total respondents in this group.

Table 5-6: Frequency Distribution of Respondents by Marital Status

	Household Location			
Marital Status of Respondent	**Rural area**	**Peri-urban area**	**Urban area**	**Total**
	# (%)	# (%)	# (%)	
Never Married or Single	14 (28.6%)	41(42.3%)	69 (45.4%)	124
Married	32 (63.3%)	52 (53.6%)	74 (48.7%)	158
Divorced or Separated		2 (2.1%)	7 (4.6%)	9
Widowed or Widower	3 (6.1%)	2 (2.1%)	2 (1.3%)	7
Total	49	97	152	298

Source: Field Survey, December 2005-February 2006

5.2.4 Educational Level

The frequency distribution of respondents by their highest level of educational attainment shows that about 11 percent of all respondents claimed to have primary education as their highest level of education. Of this percentage, 3 respondents claimed to keep livestock while 13 respondents reported not to keep. As shown in Table 5-7, 86 of total respondents claimed to have secondary education either at the junior or senior levels. Out of these, 75 respondents reported keeping livestock while 11 respondents of this group do not keep livestock in their households. Ninety-six respondents claimed to have some college diploma or trade/technical certificates and this was reported as post-secondary educational attainment as the highest level of education. Of these, 75 respondents reported keeping livestock in their households while only 21 respondents reported non-livestock keeping activities. From the distribution, this category of people also recorded the highest percentage of respondents (32.2%) that keep one form of livestock or the other in their households especially small ruminants and poultry birds.

Respondents with tertiary education claimed to have either a bachelor degree from a university or a post-graduate degree. Fifty-two respondents of all those that keep livestock are found in this category while 20 respondents reported not keeping livestock. Most respondents with no formal education or with koranic education[14] do keep one form of livestock or the other with the exception of 2 respondents that do not keep any. This result is consistent with Richardson and Whitney (1995) findings.

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[14] This could suggest that keeping of livestock might be a form of livelihood strategy or source of additional income for these households. There could also be a correlation between keeping of livestock in these households and their religious background. Information on respondents' religion background is a sensitive issue and we purposely did not include this in the survey material.

Table 5-7: Frequency Distribution of Households by Respondents' Educational Level

	Household keeping livestock		
Educational Status	**Yes, keep livestock**	**No, do not keep livestock**	**Total**
Primary education	13 (5.39%)	3 (5.26%)	16
Secondary education (Junior/Senior high)	75 (31.12%)	11 (19.30%)	86
Post-secondary education (diploma/trade/technical certificate	75 (31.12%)	21 (36.84%)	96
Tertiary education (Bachelor/University degree)	52 (21.58%)	20 (35.09%)	72
Others (Koranic/no formal education)	26 (10.79%)	2 (3.51%)	28
Total	241	57	298

Source: Field Survey, December 2005-February 2006

5.2.5 Number of Children

In Table 5-8 approximately 16 percent of respondents have no children and 45 percent have between one to four children. The mean number of children possible in each category per household in the study is 4.38 (see Table 5-3); this implies that a typical household in the study area could have about 4 to 5 children living in that household. The present study suggests that an average family in the study area is more likely to have closer to 4 children than 1 living in the household. Based on this percentage distribution, almost half of all households (about 45%) in the sample surveyed fall into this group while about 16 and 38 percent of the remaining households have no children and five or more children respectively.

Table 5-8: Frequency Distribution of Respondent's Household Location by Number of Children living in the Household

Number of Children	Rural		Peri-urban		Urban		Total (%)
	#	%	#	%	#	%	
No children	4	8	18	18.2	27	18.1	49 (16.4)
1 to 4 children	15	30	55	55.5	65	43.6	135 (45.3)
5 children and more	31	62	26	26.3	57	38.3	114 (38.3)
Total	**50**	**100**	**99**	**100**	**149**	**100**	**298 (100)**

Source: Field Survey, December 2005-February 2006

5.2.6 Household Size

In Table 5-9 concerning the household member size distribution and for households keeping livestock in the rural area, both the lower and median quartiles[15] fall in the interval 6 to 10 persons per household while in the same location the upper quartile of the distribution falls in the interval grouping for households with more than 10 persons. Likewise in the urban area, this shows the same sequence of distribution (that is both the lower and median quartiles fall in the interval 6 to 10 persons and the upper quartile falls in the interval grouping with more than 10 persons). In the peri-urban area, the sequence of this percentile measure shows that the lower, median and upper quartiles all fall in the interval 6 to 10 persons. On the contrary, households that were not keeping livestock in both peri-urban and urban locations have quite different distributions. For the peri-urban location, the lower and median quartiles both fall in the interval for households with 1 to 5 member size while the upper quartile falls in the interval of 6 to 10 member size. In the urban location, the lower quartile falls in the 1 to 5 persons grouping while the median and upper quartiles fall in the 6 to 10 persons per households. This implies that an average household keeping livestock in both rural, peri-urban and urban locations has relatively large member size from 6 to 10 persons living in that household. While an average household that is not keeping livestock in both peri-urban and urban locations has relatively small member size of 1 to 5 persons.

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[15] Quartile is a percentile measure of what percent of the total frequency is scored at or below that measure. It is usually expressed by breaking down the total of 100% into four equal parts of 25% (lower quartile), 50% (median quartile), 75% (upper quartile) and 100%.

Table 5-9: Frequency Distribution of Household Size by Location and Livestock Keeping

Household Location	Household size groupings	Yes, keep livestock (Frequency)	Cumulative Frequency	No, do not keep livestock (Frequency)	Cumulative Frequency
Rural area	1 to 5 persons	5	5	-	-
	6 to 10 persons	23	28	-	-
	More than 10 persons	22	50	-	-
Peri-urban area	1 to 5 persons	13	13	15	15
	6 to 10 persons	51	64	3	18
	More than 10 persons	13	77	3	21
Urban area	1 to 5 persons	23	23	16	16
	6 to 10 persons	47	70	12	28
	More than 10 persons	32	102	5	33

Source: Field Survey, December 2005-February 2006

5.2.7 Household Income Category

Figure 5-3 shows the distribution of households by their income categories[16]. By this distribution, respondents from households located in the rural area represent 94 percent low-income households while about 6 percent represent medium-income households in the study location. In the peri-urban and urban areas, respondents from low and medium income households represent approximately 76 and 24 percent respectively. Also, the distribution of household income category and keeping of livestock (Table 5-10) indicates that 197 (79% of those keeping livestock) respondents were from low-income households while 52 (21%) respondents were within the medium-income households. This confirms that urban livestock keeping is a form of livelihood strategy for poorer income households.

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[16] The proportion of income spent on food varies widely among households of different sizes and incomes.

Figure 5-3: Percentage Frequency Distribution of Respondents by Income Category and Household Location

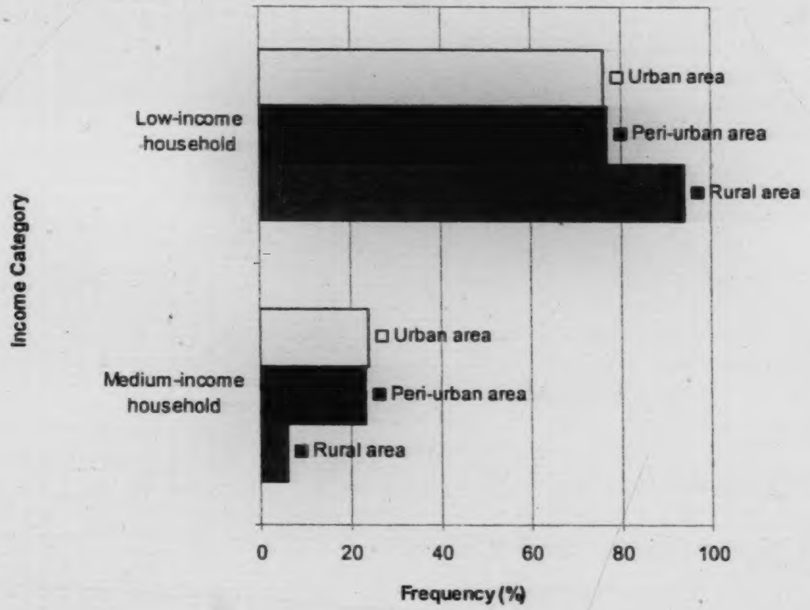


Table 5-10: Frequency Distribution of Households keeping Livestock by Income Category

Household Income Category	Household keeping livestock Yes, keep livestock (%)	 No, do not keep livestock (%)	Total (%)
Middle-income household	52 (21)	12 (20)	64 (21)
Low-income household	197 (79)	48 (80)	245 (79)
Total	249 (100)	60 (100)	309 (100)

Source: Field Survey, December 2005-February 2006

5.2.8 Employment Status

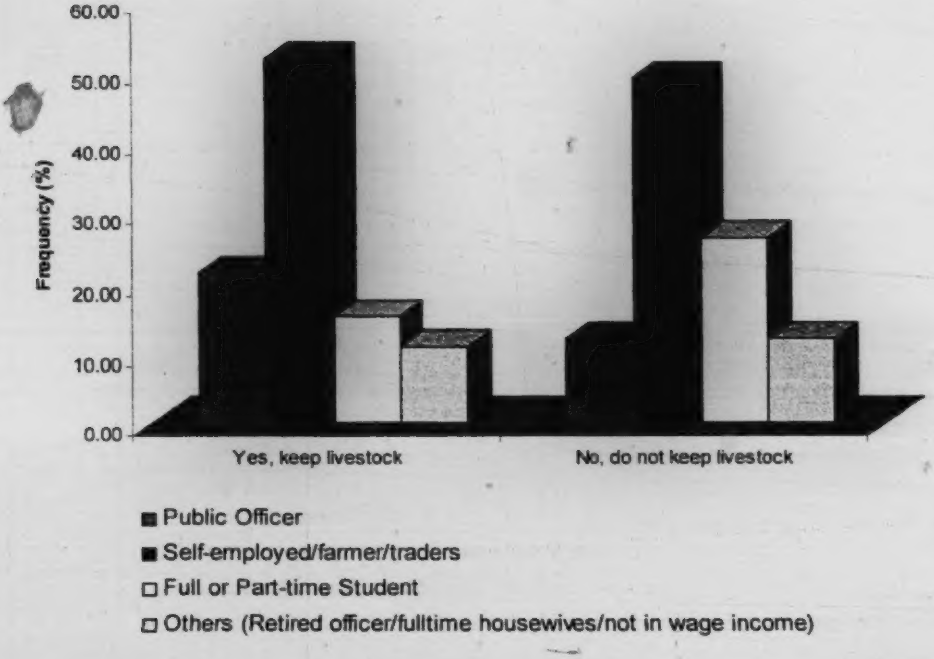
Table 5-11 and Figure 5-4 reveal that most respondents (52%) keeping livestock are either self-employed, traders or farmers. Another revealing part of the distribution is that public officers (22%) and part or full time students (16%) both represent significant proportions of respondents keeping livestock in the study locations.

Table 5-11: Frequency Distribution of Respondents by Employment Status

	Household keeping livestock		
Employment Status	Yes, keep livestock (%)	No, do not keep livestock (%)	Total
Public Officer	50 (21.46)	7 (12.28)	57
Self-employed/farmers/traders	121 (51.93)	28 (49.12)	149
Full or Part-time Student	36 (15.45)	15 (26.32)	51
Others (Retired officer/fulltime housewives/not in wage income)	26 (11.16)	7 (12.28)	33
Total (100)	233 (100)	57 (100)	290

Source: Field Survey, December 2005-February 2006

Figure 5-4: Respondent's Household Keeping Livestock by Employment Status



5.2.9 Predominant Livestock Keeping System and Type of Livestock Kept

The type of livestock kept by households differs slightly by location (Table 5-12). The most common livestock type kept by respondents' households in all study locations is poultry and this represents 31 percent of total livestock kept in the rural area, 47 percent in the peri-urban and 40 percent in the urban area. Most of these households also keep a significant number of sheep and goats whilst the distribution indicates that most of the cattle kept are in the rural households (16% of all livestock kept in the rural location). From the descriptive statistics in Table 5-3, the maximum number of different livestock kept in a sampled household are 4500, 55, 100, 30, 50, 76 and 15 for poultry, sheep, goats, pigs, rabbits, cattle and others respectively. However, households keeping more than 1000 poultry (birds) are mostly located in the peri-urban and urban areas. On the contrary, households that kept sheep and goats are found in all metropolitan locations. While more households in the rural area kept sheep their urban counterparts kept more goats. From the descriptive statistics, it can be deduced that the type and size of livestock kept is closely related to the location of the respondent's household. Poultry keeping is predominant in urban and peri-urban household locations and could be an indication of why major outbreaks of zoonotic diseases are found in these locations[17].

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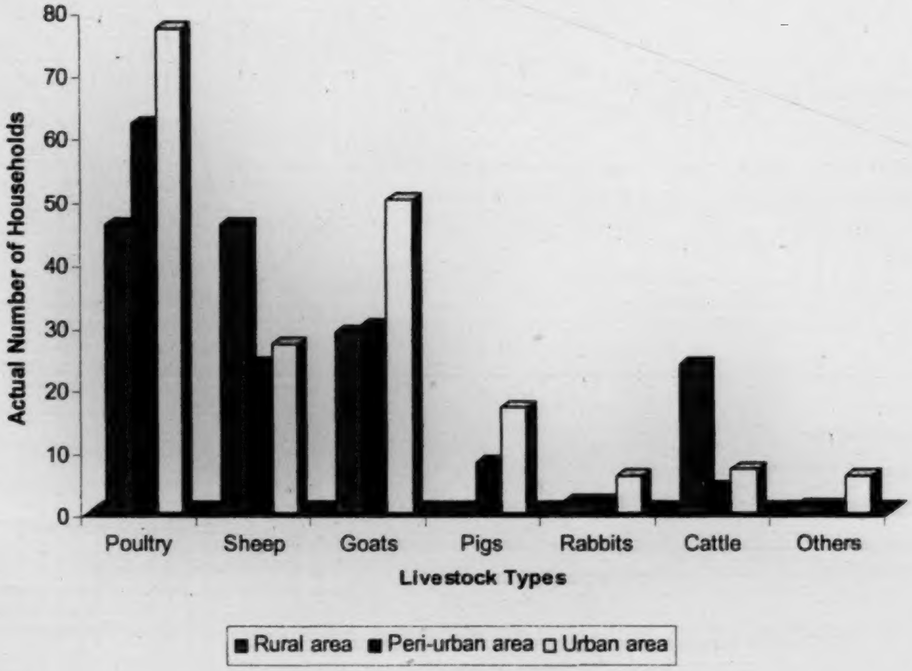
[17] The February 2006 outbreak of avian flu in Nigeria was first recorded on a poultry farm located in a sub-urban area of this present study location (Kaduna State).

Table 5-12: Frequency Distribution of Types of Livestock Kept by Household Location

Type of Livestock Kept	Rural area (# of HH)	Peri-urban (# of HH)	Urban area (# of HH)
Poultry	46	62	77
Sheep	46	24	27
Goats	29	30	50
Pigs	---	8	17
Rabbit	2	2	11
Cattle	24	4	7
Others	1	1	6

Source: Field Survey, December 2005-February 2006

Figure 5-5: Types of Livestock Kept by Respondents in Different Household Location



5.3 Differences in Risk Preferences (Perceptions) and Attitudes

5.3.1 Familiarity of respondents with health risks associated with keeping of livestock

The list of health risks identified in previous studies concerning urban agriculture in cities include: the use of untreated human and animal waste, reuse of urban waste, wastewater reuse, heavy metal contamination in soils and irrigation waters, vector breeding pools, air pollution, pollution from chemical and industrial byproducts, hospital wastes and zoonotic diseases associated with urban livestock keeping. Several appraisals of urban agriculture have also noted calls by municipal authorities for restrictions on urban livestock keeping because of noise, odours, and sanitation (mainly as a result of animal droppings which are left at roadsides). However, the potential health hazards associated with livestock keeping in general, and urban livestock keeping in particular, are more directly related to the intense, close interaction between humans and animals in densely populated areas, and lack of appropriate space for healthy practices when slaughtering animals.

During the field survey, subjects were asked to state their level of familiarity with some of these identified health concerns associated with the keeping of livestock. The level of familiarity ranges from very familiar to slightly familiar, unfamiliar, don't know and never considered it a problem before this survey. For simplicity of analysis very familiar and moderately familiar were aggregated and viewed as familiar while slightly familiar was treated as initially specified. Tables 5-13 to 5-14 show the frequency distribution and percentages (in brackets) of respondents' familiarity with any health concern identified to be associated with keeping of livestock by household location and gender. Approximately 71 percent of respondents indicated that they are familiar with some of these concerns while 14 percent indicated they are unfamiliar. About 8 percent of respondents never considered keeping livestock in cities to be associated with any health concerns until the survey while approximately 6 percent were unable to state if they were familiar with any health concerns or not by giving a "don't know" response.

With regards to familiarity of these health concerns by gender, both male (73%) and female (70%) indicate that they are familiar with some of these identified health risks while 16 percent male and 11 percent female indicate they are unfamiliar. Overall, it seems there is general risk attitude awareness to some of the health concerns associated with keeping livestock across gender. Figure 5-6 to Figure 5-7 show the frequency distribution of respondents' familiarity by metropolitan location of their households and gender.

From the cross-tabulation results in Table 5-15, respondents were asked to express their views on keeping of livestock in close proximity to where human beings live as being risky or not. For rural households, 7 percent of all respondents agreed that such activity is risky, less than 1 percent disagree with the view and approximately 10 percent of respondents were undecided on the view. In the peri-urban location, 16 percent of respondents agreed to such activity to be risky, approximately 9 percent of respondents disagreed and considered the activity not to be risky while about 7 percent of respondents remained undecided on the issue. In the urban location, 29 and approximately 14 percents of respondents both agreed and disagreed on the issue to be risky respectively. Approximately 8 percent of respondents in the urban location could not make up their minds as regards to whether the activity of keeping livestock is risky in the location where they live or not.

In Table 5-15, gender; household location (HHLOC) and educational status (EDUSTAT) of respondents are three variables that indicated a significant correlation on respondents' view on the issue of keeping livestock to be risky[18]. Chi-square tests showed that educational status and household location are both statistically significant at 1 percent while gender of respondents indicate a statistical significant at 5 percent. Both keep livestock (KPLVST) and age category (AGECAT) were not.

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[18] Among the variables included: gender, educational level and household location are the only variables that are statistically significant. There are also a large proportion of respondents that could not evaluate their levels of agreement by responding "undecided" to the statement. This group of respondents is included in this analysis because we could not consider them as a 'no response' group and most of these respondents also keep livestock (86%) in their households.

Table 5-13: Familiarity of Health Risk Concerns Associated with Keeping Livestock in Cities

	Household Location			
Familiarity	Rural area (%)	Peri-urban area (%)	Urban area (%)	Total (%)
Familiar	26 (52)	74 (79.6)	105 (73.9)	205 (71.9)
Unfamiliar	7 (14)	11 (11.8)	22 (15.5)	40 (14.1)
Never consider it as a problem before this survey	11 (22)	3 (3.2)	10 (7.1)	24 (8.4)
Don't Know	6 (12)	5 (5.4)	5 (3.5)	16 (5.6)
Total	50 (100)	93 (100)	142 (100)	285 (100)

Source: Field Survey, December 2005-February 2006

Table 5-14: Familiarity of Health Risk Concerns Associated with Keeping Livestock by Gender

Familiarity	Gender		
	Male (%)	Female (%)	Total (%)
Familiar	132 (73.3)	73 (69.5)	205 (71.9)
Unfamiliar	28 (15.6)	12 (11.4)	40 (14.04)
Never consider it as a problem before this survey	15 (8.3)	9 (8.57)	24 (8.4)
Don't Know	5 (2.8)	11 (10.5)	16 (5.6)
Total (%)	180 (100)	105 (100)	285 (100)

Source: Field Survey, December 2005-February 2006

Table 5-15: Percentage Frequency Distribution of Respondents' Who Agreed/Disagreed on the Statement of Keeping Livestock to be Risky

Keeping of Livestock "Risky"	Agree #	%	Disagree #	%	Undecided #	%	Chi-Square	P-Value
HHLOC							42.4***	0.000
Rural	21	7.1	1	0.3	29	9.9		
Peri-urban	48	16.3	26	8.8	20	6.8		
Urban	86	29.3	40	13.6	23	7.9		
KPLVST							3.73^{NS}	0.155
Yes	122	41.5	59	20.1	62	21.1		
No	33	11.2	8	2.7	10	3.4		
GENDER							5.98**	0.05
Male	109	37.1	36	12.2	44	15.0		
Female	46	15.6	31	10.5	28	9.5		
AGECAT							9.078^{NS}	0.336
< 25 yrs	33	11.5	10	3.5	17	5.9		
25-34 yrs	58	20.1	25	8.7	17	5.9		
35-44yrs	37	12.8	20	6.9	20	6.9		
45 yrs & over	24	8.4	12	4.2	15	5.2		
EDUSTAT							30.236***	0.000
No formal	7	2.5	3	1.1	18	6.3		
Primary	7	2.5	2	0.7	7	2.5		
Secondary	42	14.8	21	7.4	18	6.3		
Post-secondary	54	19.0	24	8.5	16	5.6		
Tertiary	42	14.8	12	4.2	11	3.9		

Source: Own Computations

Notes: The symbols (*), (**) and (***) denote statistically significant at the 10-, 5- and 1- percent levels of probability, respectively. NS means not statistically significant

Figure 5-6: Familiarity of Health Risk Concerns by Household Location

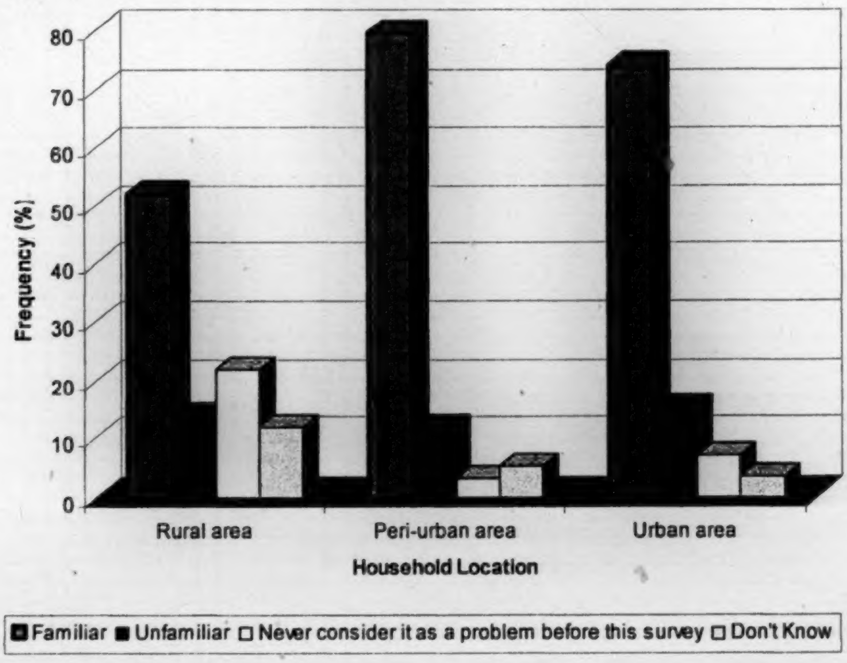
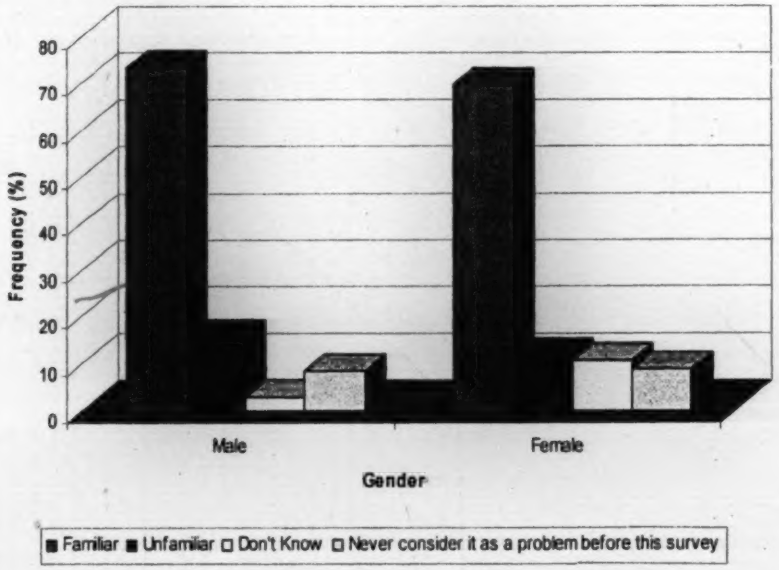


Figure 5-7: Familiarity of Health Risk Concerns by Gender



5.3.2 Perceived Potential Benefits Derived from Livestock Keeping

The cross tabulation of potential benefits derived from keeping livestock and some selected socio-demographic characteristics of the respondents are given in this section. Chi-square tests are used to test if any significant relationship exists between the benefits derived from keeping livestock and these variables. Based on this, the respondent's household location is used as a control variable to test for any apparent correlation between the respondent's educational level and benefits derived but there was no significant relationship between the two variables. Despite this, a statistically significant association was found between level of education of respondents among households located in both peri-urban and urban areas and the potential benefits they derived from keeping livestock. Some respondents' perceived benefit for keeping livestock in these locations was linked to household waste management given that livestock can eat most wastes (see Table 5-16). Since benefits tend to rise as household location changes i.e., moving from rural to urban location, apparent relationships between potential benefits of keeping livestock and other variables may actually be as a result of differences in household location. Therefore any apparent relationship can be seen as merely an underlying relationship between household location and educational status.

Tables 5-17 to 5-21 show the responses to the importance of potential benefits derived from keeping livestock and coded "1" for benefits being "unimportant" to "5" for "very important". If a respondent decides not to pick any of the responses, this is treated as "NR" (no response) and is omitted in the cross-tabulation and further analysis. For simplicity in the regression analysis, the responses of 'important" and "moderately important" are aggregated and viewed as respondents' perception of benefit being important. Contrary to this, responses "of little importance" are aggregated with "unimportant" to indicate a perception of benefit viewed as not important to the household while the response of very important was coded as it is. From the cross-tabulations and the chi-square tests conducted, all potential benefits derived from keeping livestock in all the household locations as viewed by respondents contribute statistically significant levels of importance to all households.

Table 5-16: Educational Level of Respondents and Perceived Environmental Benefit Derived From Keeping Livestock in Different Household Locations

Household Location		**Perceived Environmental Benefit**				
		Almost no benefit	Slight benefit	Moderate benefit	High benefit	Chi-Square
Rural area	Primary or Secondary education	2	6	4	3	
	Post-secondary or Tertiary education	2	0	3	0	
	No formal education or Koranic education	3	3	3	4	
	Total	7	9	10	7	**0.320****
Peri-urban area	Primary or Secondary education	1	5	5	7	
	Post-secondary or Tertiary education	14	27	19	4	
	No formal education or Koranic education	0	2	5	1	
	Total	15	34	29	12	**0.005****
Urban area	Primary or Secondary education	7	2	14	11	
	Post-secondary or Tertiary education	11	22	15	16	
	No formal education or Koranic education	0	0	1	2	
	Total	18	24	30	29	**0.038****

Source: Field Survey, December 2005-February 2006

Table 5 -17: Percentage Distribution of Livestock Importance in Providing Food Security to Respondents by Household Locations

Importance of Potential Benefits	Food Security Importance (%)					Chi-square Test (p-value)
Household Location	Unimportant	Little Importance	Moderately Important	Important	Very Important	(24.779)**
Rural area			2	14	84	
Peri-urban area	2.5	2.5	6.2	45.7	43.2	
Urban area	1.1	4.4	7.8	36.7	50	

Source: Field Survey, December 2005-February 2006

Table 5 -18: Percentage Distribution of Livestock Importance in Providing Cash Income to Respondents by Household Locations

Importance of Potential Benefits	Cash Income Importance (%)					Chi-square Test (p-value)
Household Location	Unimportant	Little Importance	Moderately Important	Important	Very Important	(40.649)***
Rural area			4	8	88	
Peri-urban area	5	13.8	16.3	18.8	46.3	
Urban area	15.9	5.7	11.4	22.7	44.3	

Source: Field Survey, December 2005-February 2006

Table 5-19: Percentage Distribution of Livestock Importance in Providing Subsistence Support to Respondent's Household by Location

Importance of Potential Benefits	Sustainability Importance (%)					Chi-square Test (p-value)
Household Location	Unimportant	Little Importance	Moderately Important	Important	Very Important	(34.098)***
Rural area	2	4	2	26	66	
Peri-urban area	1.3	14.5	21.1	21.1	42.1	
Urban area	15.9	4.5	10.2	22.7	46.6	

Source: Field Survey, December 2005-February 2006

Table 5-20: Percentage Distribution of Livestock Importance in Providing Animal Food Source to Respondents by Household Locations

Importance of Potential Benefits	Household Animal Food Source Importance (%)					Chi-square Test (p-value)
Household Location	Unimportant	Little Importance	Moderately Important	Important	Very Important	(21.133)**
Rural area	2.1		8.3	10.4	79.2	
Peri-urban area	2.6	5.3	13.2	35.5	43.4	
Urban area	4.8	3.6	20.2	26.2	45.2	

Source: Field Survey, December 2005-February 2006

Table 5-21: Percentage Distribution of Livestock Importance in Providing Employment to Respondents by Household Locations

Importance of Potential Benefits	Provision of Employment Importance (%)					Chi-square Test (p-value)
Household Location	Unimportant	Little Importance	Moderately Important	Important	Very Important	(57.731)***
Rural area	2		8.2	32.7	57.1	
Peri-urban area	39	7.8	13	15.6	24.7	
Urban area	34.8	7.1	11.9	19.5	26.7	

Source: Field Survey, December 2005-February 2006

Figure 5-8 to Figure 5-16 illustrates the results of cross tabulating each potential benefit derived from livestock keeping as perceived by respondents and the overall benefits by respondents' household location. The graphical presentation shows that respondents in the rural, peri-urban and urban areas all considered additional cash income derived from keeping livestock in their households to be of high benefit to them (Figure 5-8). It seems that keeping of livestock in different household locations can be considered generally as a form of livelihoods to many households in the study location.

Figure 5-9 reveals that respondents in the urban area consider animal manure sale to be of almost no benefit to their households. Peri-urban households consider it to be of slight benefit while rural households considered deriving slight to moderate benefits from the sale of animal manure. Respondents in the rural households placed a high benefit on livestock keeping as a means of providing employment to household members and to other members within the community[19] (Figure 5-10). A high percentage (about 65%) of respondents in the rural location viewed livestock keeping in their households in providing food security to be of high benefit to the household (Figure 5-11) while about 43 percent of respondents in both peri-urban and urban areas also viewed provision of food security by keeping livestock to be of high benefits to household members.

With regards to cultural and social benefits derived from keeping livestock, both rural (38%) and urban residents (43%) viewed this benefit to be relatively high (Figure 5-12). A larger proportion of peri-urban residents viewed this benefit as just contributing a slight benefit to cultural and social needs of the households. The range of contribution of livestock keeping in the management and reduction of household waste was viewed by respondents in all household locations to be of slight to moderate benefit (Figure 5-13). Over 80 percent of respondents in rural areas attributed the keeping of livestock to contribute a high benefit to their subsistence means (Figure 5-14). In Figure 5-15, respondents from all household locations cited all the potential benefit areas as contributing significantly to their household. Overall, all households viewed additional cash income, household food security and subsistence means as contributing potentially high benefits to their welfare as a result of keeping livestock in these households (Figure 5-16).

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[19] Personal communication with some of these respondents confirmed that women and children indirectly get additional income from the sale of 'dusa' shaft from milled grain, which they sell to livestock owners as livestock feeds. They pick up the leftover shafts from milling house when processing local corn meal flour "tuwo".

Figure 5-8: Percentage distribution of respondents' view on benefit derived as additional cash income from livestock keeping

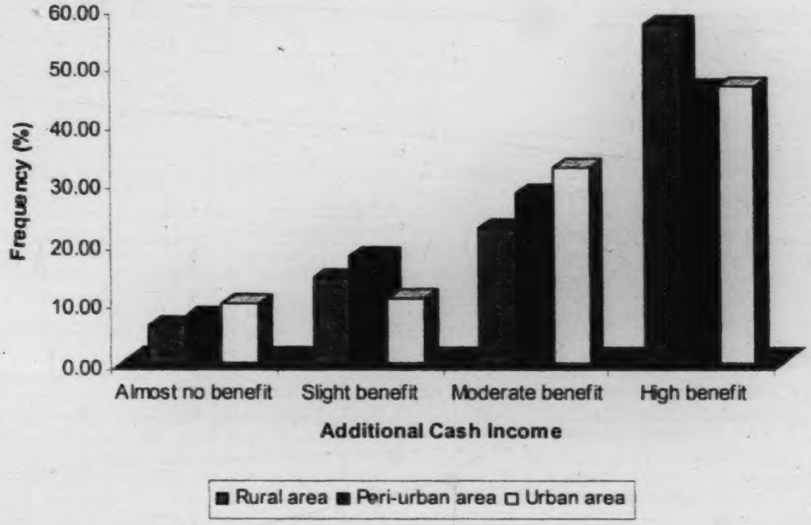


Figure 5-9: Percentage distribution of respondents' view on benefit derived from the sale of animal manure for keeping livestock

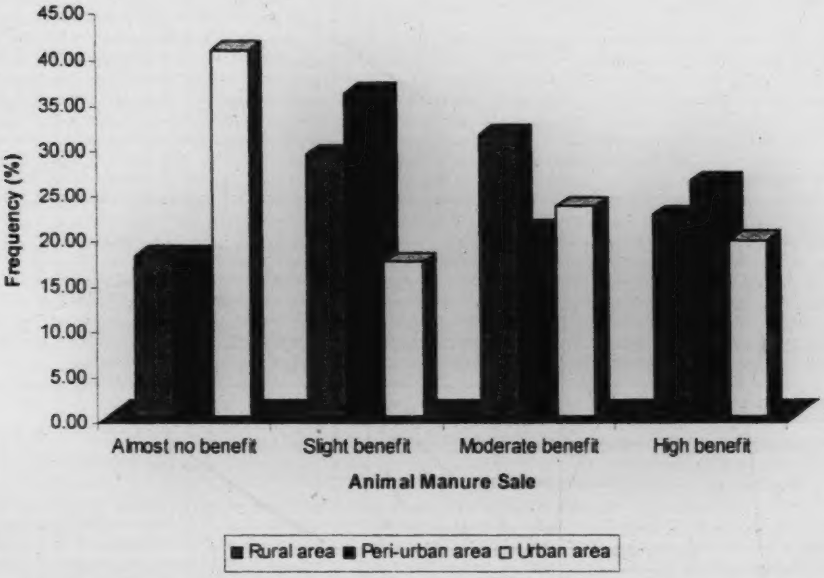


Figure 5-10: Percentage distribution of respondents' view on benefit derived in providing employment for keeping livestock

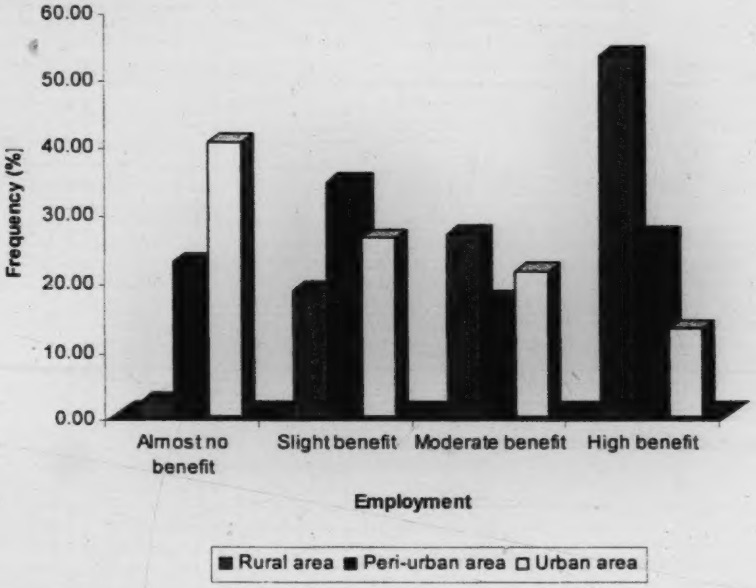


Figure 5-11: Percentage distribution of respondents' view of deriving food security benefits

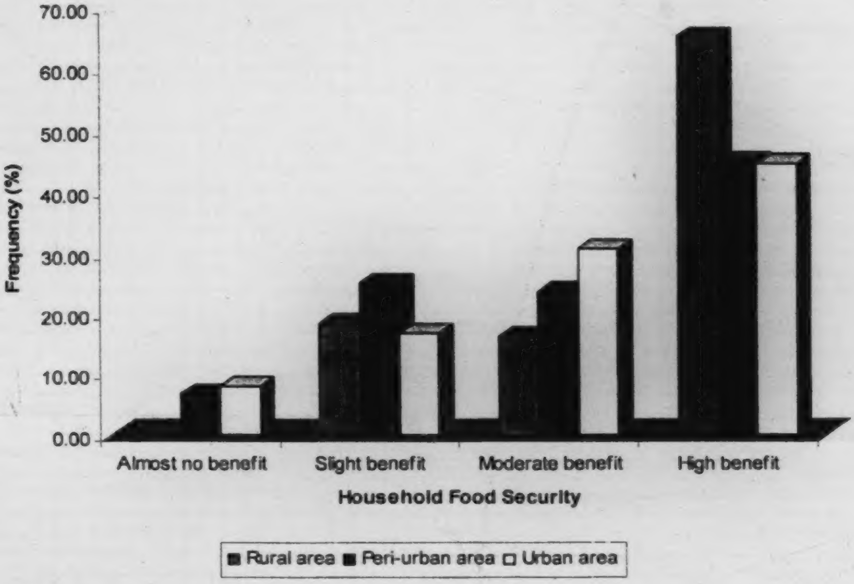


Figure 5-12: Percentage distribution of respondents' view on cultural and social benefits derived from keeping livestock

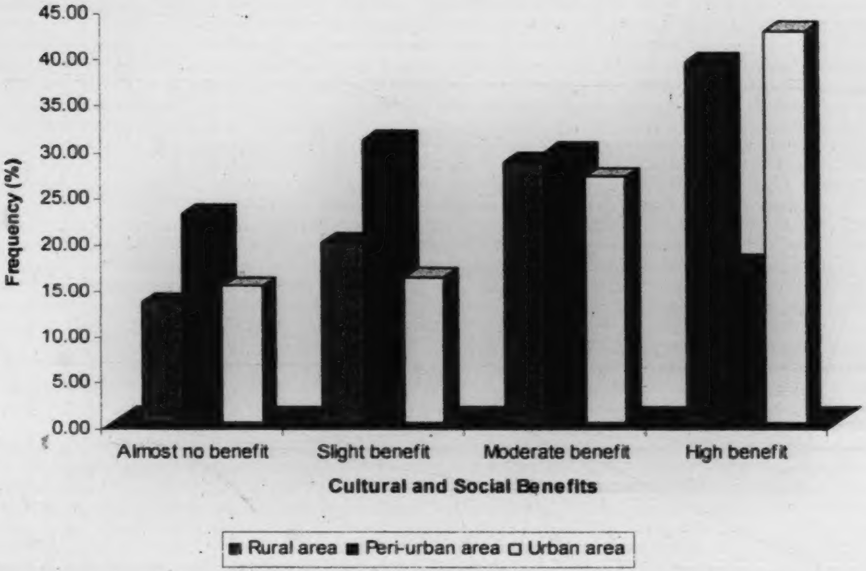


Figure 5-13: Percentage distribution of respondents' view on benefit derived from household waste management

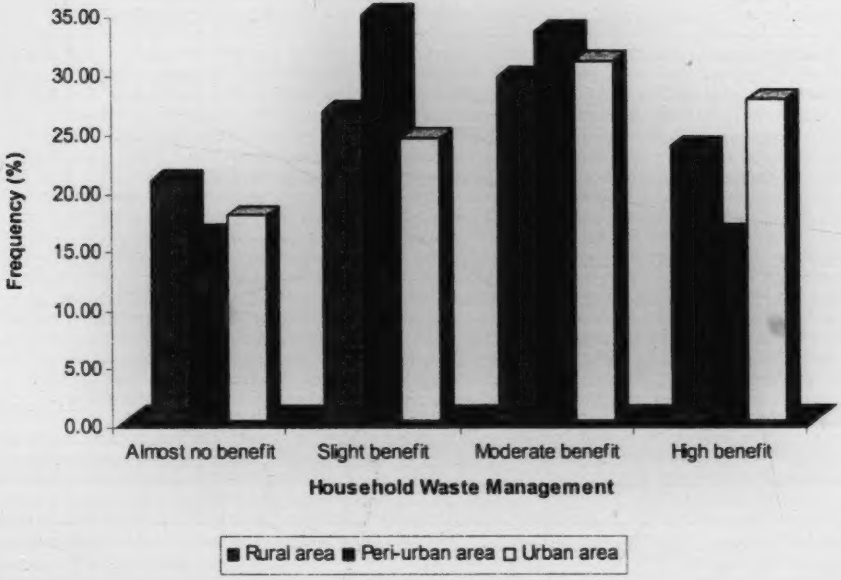


Figure 5-14: Percentage distribution of respondents' view of deriving subsistence support benefit

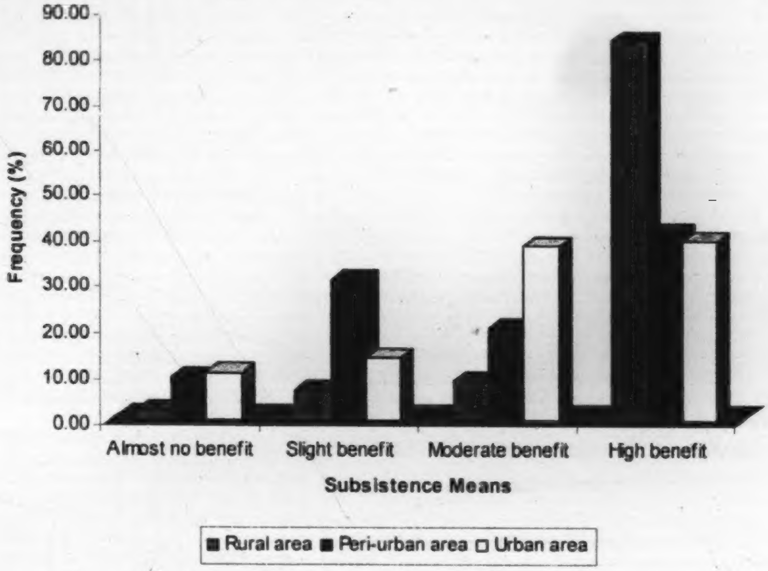


Figure 5-15: Percentage distribution of respondents' view on overall benefits derived from livestock keeping

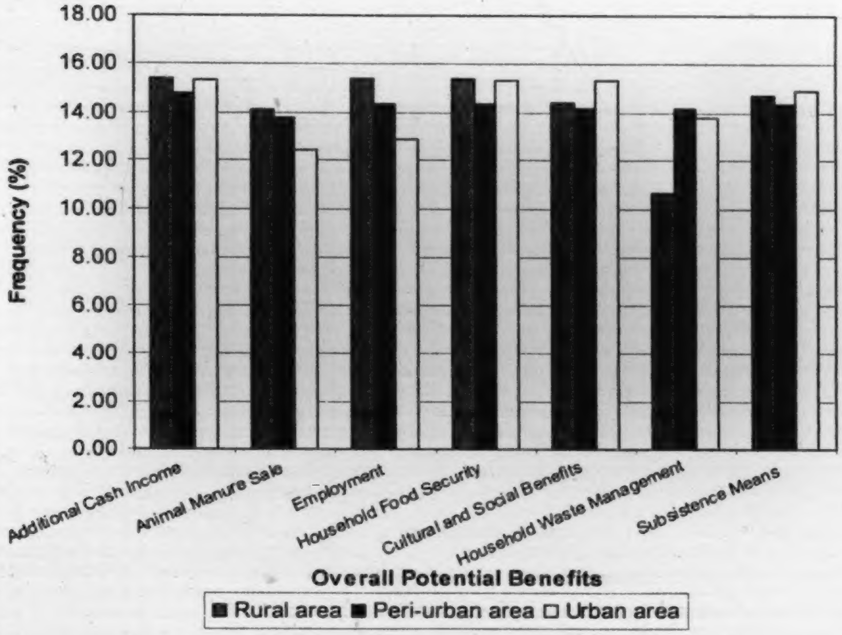
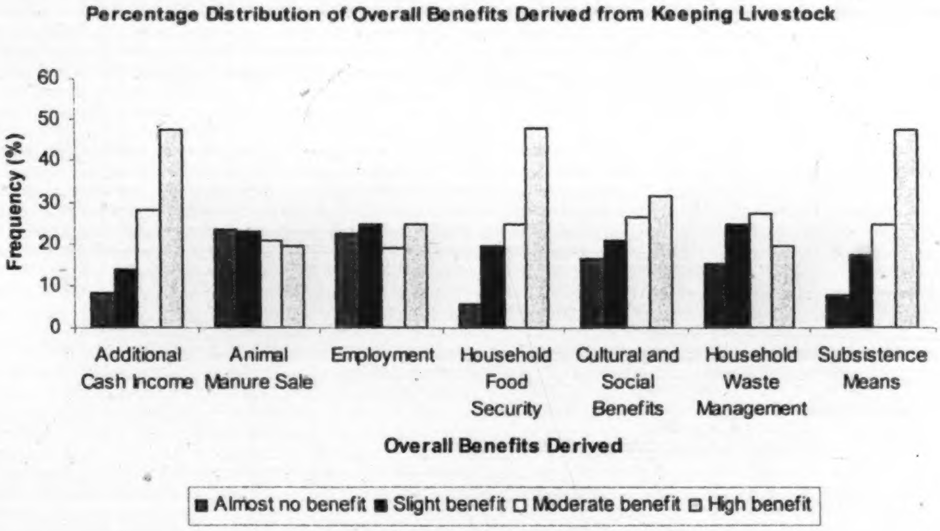


Figure 5-16: Percentage Distribution of Overall Benefits Derived from Livestock Keeping



5.4 *Comparisons of Means of Average Overall Perceived Risks across Selected Socioeconomic Variables*

In Tables 5-22 to 5-45, analyses were conducted to compares means of overall perceived risks across some selected socioeconomic variables that indicated some significant levels of association with keeping of livestock in the previous sections of this study. One-Way ANOVA tables also show the analysis of variance for each dependent variable across the selected socioeconomic variables (household keeping livestock versus those not keeping livestock, gender, mean age and metropolitan location of respondents' household, number of children, household size, marital status and educational status to mention a few). Various tests that show the means of average perceived overall risks and benefits are equal across these variables are conducted. Tests of hypothesis that the means of two or more groups of these variables are not significantly different are also carried out. The various tests used are the test of homogeneity of variances using Levene Statistic to confirm if the variances of the groups are different. The standard *F* statistic is used to test the equality of variance assumption (ANOVA assumption) which is robust to unequal variances when sample sizes are equal or nearly equal. The Brown-Forsythe and Welch tests are two analysis of variance methods used in this One-Way ANOVA that provide an alternative method to the *F* statistic[20]. The Welch statistic cannot be computed if any of the group has zero standard deviation. Moreover, sample sizes of all groups have to be greater than or equal to zero (Welch 1947).

Table 5-22: Comparison of Means of Perceived Risk across Households Keeping/Not Keeping Livestock

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
No, do not keep livestock	60	4.27	1.436	0.185	3.90	4.64	1	7
Yes, keep livestock	249	4.00	1.564	0.099	3.81	4.20	0	7
Total	309	4.06	1.541	0.088	3.88	4.23	0	7

Table 5-23: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	**Decision**
1.610	1	307	.205	**Do not Reject H_0**

Table 5-24: ANOVA Table Showing Average Overall Perceived Risk across Household Keeping /Not Keeping Livestock

	Sum of Squares	df	Mean Square	F	Sig.	**Decision**
Between Groups	3.315	1	3.315	1.398	.238	**Do not Reject H_0**
Within Groups	728.188	307	2.372			
Total	731.503	308				

---

[20] These two tests are used to confirm the results from the standard *F* statistic when both the variances and sample sizes differ. For the (Welch 1951) statistic, an approximate test for the equality of means without the homogeneous variance assumption is used. In this case, the *F* statistic reliability is prone to give incorrect results.

Table 5-25: Robust Tests of Equality of Means

	Statistic (a)	df1	df2	Sig.	Decision
Welch	1.552	1	95.709	.216	**Do not Reject H_0**
Brown-Forsythe	1.552	1	95.709	.216	**Do not Reject H_0**

a. Asymptotically F distributed.

From the results in Tables 5-22 to 5-25, it is seen that the null hypothesis of equality of means is not rejected at both 5% and 1% confidence levels across the variable household keeping/ not keeping livestock. This indicates that the average overall perceived risk of respondent's household does not differ across household keeping livestock or household that does not keep livestock. The standard *F* statistic test to confirm the ANOVA assumption, the Levene test of homogeneity of variances (Levene 1960) and the Robust tests of equality of variances (Brown and Forsythe 1947a; 1974b) all confirmed that there is no significance difference in the average overall perceived risk of both respondents that keep livestock and those that do not keep. Even though the analysis in Table 5-22 to compare the means indicates a slight increase in the average perceived risk of those respondents that do not keep livestock from those that kept livestock, the difference in variance was not significant.

Table 5-26: Comparison of Means of Perceived Risk across Gender

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Female	116	4.10	3.011	.280	3.55	4.66	1	7
Male	193	4.05	3.007	.216	3.62	4.47	1	7
Total	309	4.07	3.004	.171	3.73	4.40	1	7

Table 5-27: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	Decision

0.108	1	307	.742	**Do not Reject H_0**

Table 5-28: ANOVA Table Showing Average Overall Perceived Risk across Gender

	Sum of Squares	df	Mean Square	F	Sig.	**Decision**
Between Groups	.234	1	.234	.026	.872	**Do not Reject H_0**
Within Groups	2779.339	307	9.053			
Total	2779.573	308				

Table 5-29: Robust Tests of Equality of Means

	Statistic (a)	df1	df2	Sig.	**Decision**
Welch	.026	1	242.104	.872	**Do not Reject H_0**
Brown-Forsythe	.026	1	242.104	.872	**Do not Reject H_0**

a. Asymptotically F distributed.

Table 5-30: Comparison of Means of Perceived Risk across Respondent Household Location

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
Rural area	51	4.21	1.315	.184	3.84	4.58	1	7
Peri-urban area	103	3.91	1.576	.155	3.60	4.22	0	7
Urban area	155	4.10	1.587	.127	3.85	4.35	0	7
Total	309	4.06	1.541	.088	3.88	4.23	0	7

Table 5-31: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	**Decision**
.623	2	306	.537	

				Do not Reject H_0

Table 5-32: ANO[illegible]able Showing Average Overall Perceived Risk across Household Location

	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	3.738	2	1.869	.786	.457	**Do not Reject H_0**
Within Groups	727.765	306	2.378			
Total	731.503	308				

Table 5-33: Robust Tests of Equality of Means

	Statistic(a)	df1	df2	Sig.	Decision
Welch	.847	2	143.572	.431	**Do not Reject H_0**
Brown-Forsythe	.858	2	240.754	.425	

a. Asymptotically F distributed.

From the results in Tables 5-26 to 5-33, it is seen that the null hypothesis is not rejected at both 5% and 1% confidence levels across variables gender and household location. This indicates that the average overall perceived risk of respondent's household does not differ across gender and household location. The standard *F* statistic test to confirm the ANOVA assumption, the Levene test of Homogeneity of variances and the Robust Tests of Equality of Variances all confirmed that there is no significance difference in the average overall perceived risk of a respondent being a male or female and household location. The analysis in Table 5-26 indicates an equal variance in average risk as perceived by a female or male respondent and by the location of the respondent's household.

Table 5-34: Comparison of Means of Perceived Risk across Respondent's Household Size

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
1 to 5 persons	72	4.75	2.925	.345	4.06	5.44	1	7
6 to 8 persons	79	3.96	3.019	.340	3.29	4.64	1	7
9 to 10 persons	57	4.47	2.989	.396	3.68	5.27	1	7
More than 10 Persons	75	3.48	2.974	.343	2.80	4.16	1	7
Total	283	4.14	3.002	.178	3.79	4.49	1	7

Table 5-35: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	**Decision**
1.758	3	279	.155	**Do not Reject H_0**

Table 5-36: ANOVA Table Showing Average Overall Perceived Risk across Household Size

	Sum of Squares	df	Mean Square	F	Sig.	**Decision**
Between Groups	68.309	3	22.770	2.569	.055[b]	**Reject H_0**
Within Groups	2473.317	279	8.865			
Total	2541.625	282				

Table 5-37: Robust Tests of Equality of Means

	Statistic(a)	df1	df2	Sig.	**Decision**

Welch	2.580	3	150.718	.056[b]	**Reject H_0**
Brown-Forsythe	2.569	3	271.146	.055	**Reject H_0**

a. Asymptotically F distributed.
b. Significant at 10% confidence level

From the results in Tables 5-34 to 5-37, it is seen that the null hypothesis is not rejected at both 5% and 10% confidence levels across the variable household size for the Levene test of Homogeneity of variances (equal variance across household size). Contrary to the finding for the Levene test, the *p* value associated with the standard ANOVA *F* statistic (Table 5-36) is not significant at 5% level of confidence but significant at 10% level of confidence. This indicates that the average overall perceived risk of respondent's household does slightly differ across household size (unequal variance). As with the standard F statistic, the Welch statistic and the Brown-Forsythe statistic are both significant below 0.1 (at 10% confidence level). Though, the Welch statistic is very close to 0.05, but not significant at 5% confidence level.

Tables 5-38 to 5-45 show results for testing the null hypothesis of equal variances across marital and educational statuses of respondents with respect to their overall perceived risk. From Tables 5-38 to 5-41, there is a slight variation in the means across individual respondent's marital status to the total mean. Following that the Levene statistic was rejected at 1% confidence level but this was not conclusive. But the other standard Welch and Brown-Forsythe statistics were not rejected at 10% confidence level and these confirmed that there is no significance difference in the average overall perceived risk across respondents' marital status. In the same line, all the three standard statistics (Tables 5-42 to 5-45) for testing the null hypothesis of equal variances across educational status were not rejected at both 5% and 1% confidence levels.

Table 5-38: Comparison of Means of Perceived Risk across Respondent's Marital Status

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Never Married or Single	124	3.90	3.011	0.270	3.37	4.44	1	7
Married	158	4.15	3.006	0.239	3.68	4.62	1	7
Divorced or Separated	9	3.00	3.000	1.000	.69	5.31	1	7
Widowed or Widower	7	6.14	2.268	0.857	4.05	8.24	1	7
Total	298	4.06	3.004	0.174	3.72	4.40	1	7

Table 5-39: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	**Decision**
57.079	3	294	.000	**Reject H_0**

Table 5-40: ANOVA Table Showing Average Overall Perceived Risk across Marital Status

	Sum of Squares	df	Mean Square	F	Sig.	**Decision**
Between Groups	44.862	3	14.954	1.668	.174	**Do not Reject H_0**
Within Groups	2636.050	294	8.966			
Total	2680.913	297				

Table 5-41: Robust Tests of Equality of Means

	Statistic(a)	df1	df2	Sig.	**Decision**[b]
Welch	2.319	3	18.157	.110	**Do not Reject H_0**
Brown-Forsythe	1.927	3	38.545	.141	**Do not Reject H_0**

a. Asymptotically F distributed. b.10% confidence level

Table 5-42: Comparisons of Means of Perceived Risk across Educational Status of Respondents

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Primary or Secondary education	102	4.06	3.014	0.298	3.47	4.65	1	7
Post-secondary or Tertiary education	168	4.14	3.006	0.232	3.69	4.60	1	7
No formal education or Koranic education	28	4.43	3.024	0.571	3.26	5.60	1	7
Total	298	4.14	3.002	0.174	3.80	4.48	1	7

Table 5-43: Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.	**Decision**
1.392	2	295	.250	**Do not Reject H_0**

Table 5-44: ANOVA Table Showing Average Overall Perceived Risk across Educational Status

	Sum of Squares	df	Mean Square	F	Sig.	**Decision**
Between Groups	3.005	2	1.502	.166	.847	**Do not Reject H_0**
Within Groups	2673.076	295	9.061			
Total	2676.081	297				

Table 5-45: Robust Tests of Equality of Means

	Statistic(a)	df1	df2	Sig.	**Decision**
Welch	.163	2	74.310	.850	**Do not Reject H_0**
Brown-Forsythe	.165	2	110.857	.848	**Do not Reject H_0**

a. Asymptotically F distributed.

5.5 Factor Analysis Overview

Factor analysis is a procedure used to uncover the latent structure (dimensions) of a set of variables. This analytical procedure is “non-dependent” since a dependent variable specification assumption is not required. It is used to reduce attribute space from larger number of variables to a smaller number of factors (Hair et al. 1995). The term was first introduced by Thurstone (1931) and it examines the correlations among the attributes to identify the basic dimensions. The following are the major reasons for conducting factor analysis (Garson 2004);

- To reduce a large number of variables to a smaller number of factors for modeling purposes;
- To select a subset of variables from a large set based on which original variables have the highest correlations with the principal component factors;
- To create a set of factors to be treated as uncorrelated variables as one approach to handling multicolinearity in such procedures as multiple regressions;
- To validate a scale or index by demonstrating that its constituent items load on the same factor, and to drop proposed scale items which cross-load on more than one factor;
- To establish that multiple tests measure the same factor, thereby giving justification for administering fewer tests;
- To identify clusters of cases and/or outliers and finally;
- To determine network groups by determining which sets of people cluster together

There are several different types of factor analysis and the most commonly used one is the principal component analysis (PCA). In applying the PCA to this present study, the exploratory factor analysis (EFA) is adopted, which seeks to uncover the underlying structure of a relatively large set of variables as specified in the scale items discussed fully in the next section of this chapter. The exploratory factor analysis is the most common form of factor analysis and is not based on any pre-established theory (Tucker and MacCallum 1993). The a priori assumption is that any indicator may be associated with any factor and the method uses factor loadings to intuit the factor structure of the data. The factors loaded as components from a PCA represent both common and unique variance[21] of the variables and is seen as a variance-focused approach that seeks to reproduce both the total variable variance with all components and to reproduce the correlations (Jolliffe and Morgan 1992).

In this present study an alternative approach to the 'revealed preference' method, advocated by Starr (1969), called the 'expressed preferences' is adopted. This approach employs questionnaires to measure respondents' attitudes toward risks that could result from activities related to keeping of livestock. More specifically, subjects are asked to rate the overall perceived riskiness of a number of different hypothetical health concerns. Each concern was broken down into six questions to depict the risk attributes of the activity involved (e.g., involuntariness, catastrophic potential, severity of consequences, control, knowledge and experience). The scale ratings were computed as the raw scores of the items and used in the factor analysis. A seven-point Likert scale was used for each item where higher scores reflect higher construct values (refer to Table 5-47).

5.5.1 Principal Components Analysis (PCA)

This section adequately deals with the analysis of the psychometric scales used in assessing individual's perceived risk attributes to achieve the third objective of this study. A question that could come to mind is "why do people adopt harmful behavioural patterns, such as smoking and overeating, assuming they are fully aware of health risks involved"? The same response could be used to answer the question to why individuals would want to keep livestock close to their households despite the perceived human and environmental health risks associated with such activities.

One of the specific objectives of this study is to assess individual household's perceived risk associated with keeping of livestock in their vicinity and attitudes towards such risks by rating the riskiness of such concerns. In doing this, an examination of the psychometric dimensions of some hypothesized constructs identified as some of the health concerns associated with keeping of livestock in all three locations was undertaken. Principal component factor analysis was used to evaluate the hypothesized constructs of these risk characteristics (attributes) based on qualitative responses to questions relating to benefits and health concerns associated with keeping of livestock (Table 5-45). Subjects were asked to rate six (6) perceived human health and environmental-related questions and these were quantified on a subset of six (6) risk characteristics; refer to Table 5-46.

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[21] The Common factor analysis is another form of factor analysis commonly used in confirmatory factor analysis (CFA) and uses principal axis factoring (PFA) rather than principal component analysis (PCA). The major difference between the PFA and PCA is that PFA is a correlation-focused approach seeking to reproduce the inter-correlation among variables. The factors from PFA represent the common variance (correlation) of variables, excluding unique variance.

Following previous studies that have used the psychometric approach in assessing perception of risk, the six major attributes considered in this analysis are involuntariness, catastrophic potential, severity of consequence, control over risk, knowledge of risk to scientists and experience of risk to those exposed (Table 5-46). A different wording was used for questions related to knowledge and experience of risk associated with keeping livestock (see Appendix A-4) for sample of questionnaire. Also refer to (Table 5-48) for a full description of all related questions to this analysis.

Data analysis in this section of present research proceeded in two main steps. In the first step, Principal Components Analysis (PCA) with varimax rotation is applied to the items. Using PCA, nine factors were developed and summarized in the reduced survey questions on perceived human and environmental risk attributes and behaviour. These factors are normalized to be between 0 and 1 and Table 5-48 summarizes these results. Quite a few respondents chose not to answer some questions, which may be due to misunderstanding of a question, or personal preference not to divulge personal information. The main reasons pointed out were (a) very long questionnaire, and (b) lack of time. In order to account for these missing data points, a relatively small proportion of some responses were recoded for proper imputation and missing values on the scale items were omitted completely. Each individual scale measure was then subjected to reliability test of Cronbach's alpha to measure the internal reliability of the scales. To ensure that each scale item is measuring the same construct and not different, some items on the scale has to be reverse scored so that they are all positively correlated (convergent validity)[22].

The general formula for Cronbach's alpha is $\alpha = \dfrac{N \cdot \bar{r}}{1 + (N-1) \cdot \bar{r}}$

Where N is the number of observations and r-bar is the inter-item correlation between variables. Analysis of each item was performed using the Statistical Package for the Social Sciences (SPSS 15.0) software. After deleting appropriate items in each scale, the Cronbach's alpha was maximized so that the correlation between items ensured that every question in the scale was measuring appropriate attitude.

In the second analytical step, the quantitative contribution of each of the continuous variables (the principal components and the variable representing the respondent's age) and also of the set of dummy variables (i.e., other socio-demographic variables) on the overall perceived riskiness of keeping livestock were compared through the adjustment of a logistic regression model (Table 6-5).

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[22] Convergent validity is used to investigate Construct validity and refers to the extent to which different measurements reflect the same construct (Campbell and Fiske 1959, Cook and Campbell 1979, Churchill 1979). This is quite different from Discriminant validity which refers to the degree to which the scale does not correlate with other measures designed to assess dissimilar constructs.

Table 5-46: Perceived Benefits versus Perceived Risk Characteristic Statements

Perceived Benefit Statement	Risk Characteristic Statement
Additional income/cash for the household members	Keeping livestock close to where people live means no harm to human
Animal manure sale	Livestock wastes/smell/odor/dust from poultry/pig housing are not a concern
Making jobs available for the people living in the neighbourhood	Animal wastes can be stored and disposed anywhere
Provision of sufficient food in quantity and quality for all members of the household	Eating food made from animal sources and by-products is not harmful
Cultural and social benefits	Animal wastes can be applied to land and cause no harm to sources of drinking water
Reducing and managing household wastes	Touching animals that are sick, their beddings or inhaling contaminated air from poor housing are not a concern
Providing means of support (subsistence) for the household during economic hardship	

Table 5-47: Description of Overall Risk, General Attitudinal Factors and Perceived Risk Attributes

		Scale Endpoints	
Scale	**Description of Scale**	**Low (1)**	**High (7)**
Overall Riskiness	How risky are the outcomes from activity associated with keeping of livestock?	Not Risky	Extremely Risk
Involuntariness	To what extent is the population exposed to the risk associated with each activity, substance or technology voluntarily?	Voluntary	Involuntary
Catastrophic Potential	To what magnitude does this activity, substance or technology has the potential to cause death and catastrophic destruction?	Very small catastrophic potential	Very high catastrophic potential
Severity of Consequences	Should the risk associated with this activity, substance or technology occurs, how is it likely to produce fatal consequences?	Nonfatal	Fatal
Control	To what extent could the exposed population avoid the risk associated with each activity, substance or technology?	Uncontrollable	Controllable
Knowledge	How aware is the exposed population of the risk associated with each activity, substance or technology?	Known Precisely	Not Known Precisely
Experience	To what extent can the exposed population handle the risk associated with each activity, substance or technology?	No Experience	Great Experience
Importance of keeping livestock	How important is it to you, your household members and the community at large in keeping livestock?	Not at all important (1)	Very important (5)
Benefits derived from keeping livestock	What perceived benefits do you or your household members derived as a result of keeping livestock?	No benefit at all (1)	High benefit (4)

5.5.2 Discussion of PCA Results

From the factor analysis conducted using principal components as the extraction technique and varimax rotation, nine distinct factors or attributes are revealed to be associated with perceived risk with high factor loadings[23] (>= 0.5) on them. The nine risk attributes identified accounted for a total variance of 66.2% (KMO = 0.695; Bartlett test p = .000). These results are summarized in Table 5-48. In accordance with the meaning of the corresponding items with higher loadings, the encountered principal components were labeled as follows: FAC1_1; FAC1_2; FAC1_3; FAC1_4; FAC1_5; *FAC1_6; FAC1_7; FAC1_8, FAC1_9 (Table 5-48).*

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[23] In most studies like this, a factor loading of 0.45 might be considered as "high" for dichotomous items but for Likert scale items a 0.6 factor loadings are usually required to be considered as "high".

All the five attributes under severity of consequences all loaded on Component 1 (i.e., FAC1_1), which accounted for 17% of the variance and labeled as *Severity Factor*. Component 2 labeled as *Environmental Factor* (FAC1_2) accounted for over 10% of the variance and two major attributes that loaded highly on this factor are under the environmental control of health risks associated with livestock keeping. Component 3 (FAC1_3) which is a mixture of control and catastrophic potential all loaded highly on the component. This component, which we labeled *Control Factor* accounted for approximately 8% of the variance. Component 4 (FAC1_4), labeled *Knowledge Factor* included all the three knowledge attributes and accounted for about 8% of the variance. Component 5 (FAC1_5) included two catastrophic potential attributes and accounted for about 6% of the variance. Components 6 (FAC1_6), 7 (FAC1_7) and 8 (FAC1_8) are labeled *Awareness, Involuntary Exposure* and *Experience Factors* respectively. These three factors together with Component 9 (FAC1_9), contributed 18% to the variance. The communalities on all these attributes ranged from 53% to 78% (see last column of Table 5-48). The total explained variance in the questionnaire items and the analysis confirmed findings of previous research on assessment of perceived risk characteristics. Furthermore, these results are congruent with those obtained in other studies using the psychometric approach in risk perception assessment and found high reliabilities for two or more of these nine attributes (Slovic 1997; 1992; Fischhoff et al. 1978).

Principal Component Analysis is also used to reduce the original seven question items to measure the perceived benefits households derive from keeping livestock to two new factors, with a total variance of 58% (KMO = 0.704; Bartlett test p = .000). The Kaiser-Meyer-Olkin (KMO) measures the sampling adequacy which should be greater than 0.5 for a satisfactory analysis. Looking at the table below, the KMO measure is 0.704. From the same table, we can see that the Bartlett's test of sphericity is significant. That is, its associated probability is less than 0.05. In fact, it is actually 0.001. This means that the correlation matrix is not an identity matrix. Results of this analysis are presented in Table 5-52. Considering the meaning of the items with higher loadings in each dimension, these dimensions were labeled *FAC2_1- Economic/Social Benefits* and *FAC2_2- Cultural/Nutritional Benefits*. Cronbach's alpha for the two dimensions both exceed 0.6, which can be considered as reasonable levels for internal consistency within each of the two dimensions for an exploratory study like this.

Finally, the results of the application of PCA to the 5 items selected to measure the importance of potential benefits household members attributed to livestock keeping are presented in Table 5-53. These items were reduced to two new factors that jointly explain approximately 75% of the data total variance (KMO = .640; Bartlett test p = .000). These dimensions were labeled *FAC3_1-"Livelihood Strategy"* (income smoothing) and *FAC3_2-"Food Security"* (consumption smoothing) and the Cronbach's alpha coefficient for these items is 0.74. This visibly indicates a very good degree of internal consistency within each of these measures.

Table 5-48: Principal Component Analysis and Factor Loadings across Nine Perceived Risk Attributes

		Rotated Component Matrix (a)[24]								
VARIABLES	FAC 1_1	FAC 1_2	FAC 1_3	FAC 1_4	FAC 1_5	FAC 1_6	FAC 1_7	FAC 1_8	FAC1_9	Communality
INVOL1							.779			.737
INVOL2							.561			.685
INVOL3						.623				.563
INVOL4						.794				.644
INVOL5							.529			.686
COP1										.535
COP2					.683					.777
COP3					.773					.715
COP4			.687							.695
COP5									.599	.627
SOC1	.708									.677
SOC2	.720									.666
SOC3	.646									.636
SOC4	.563									.703
SOC5	.542								.540	.755
CON1			.509							.697
CON2		.847								.775
CON3		.777								.718
CON4			.662							.575
CON5			.706							.675
KNOW1				.625						.682
KNOW2				.683						.539
KNOW3				.760						.608
EXP1								.704		.638
EXP2				.502						.574
EXP3								.520		.530

The table above shows the loadings of the twenty-seven variables on the nine factors extracted. The higher the absolute value of the loading, the more that factor contributes to the variable. The gap on the table represent loadings that are less than 0.5, this makes reading the table easier. All loadings less than 0.5 were suppressed in the component matrix.

Notes: INVOL= involuntariness; COP=catastrophic of potential; SOC=severity of consequences;

CON=control of risk; KNOW=knowledge of risk; EXP= experience

INVOL1= voluntary keeping of livestock close to where people live and unaware of the health concerns

INVOL2= voluntary exposure to livestock wastes/smell/dust and odor from their housing

INVOL3= voluntary consumption of animal food products with some concerns with health risk and;

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[24] Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 14 iterations.

INVOL4= voluntary application of animal wastes to farmlands even when they are associated with some health risks;

INVOL5= voluntary touching of animals that are sick, their beddings and contaminated housing units

COP1= health risks associated with living close to where livestock are kept causing harms to people

COP2=health risks associated with poor livestock housing to have chronic/catastrophic potential;

COP3= health risks associated with poor management of livestock wastes to have chronic/catastrophic potential;

COP4= health risks associated with animal wastes applied to farmland to have chronic/catastrophic potential

COP5= health risks associated with touching sick animals causing chronic/catastrophic harms

SOC1= consequences of a zoonotic disease leading to death;

SOC2= health risk consequences from livestock wastes/dust/smell from poor housing to be fatal;

SOC3= death resulting from eating contaminated food made from animal source;

SOC4= health risk consequence that could be fatal as a result of applying animal wastes to crop land and contaminating water source

SOC5= health risk consequence of touching sick animals and their beddings causing illness that could lead to death

CON1= control of human health concerns associated with keeping livestock within household

CON2= control of air pollution resulting from dust and smell from poor livestock housing

CON3= control of environmental pollution from animal wastes;

CON4 = control of health risk associated with eating food from animal sources;

CON5= control of health risk related to animal wastes applied to farmland and drinking water sources;

KNOW1= knowledge of risk associated with keeping of livestock known to those involved in the activity;

KNOW2= knowledge of risks known to those living close to where livestock are kept;

KNOW3= knowledge of risk known to science;

EXP1= experience in handling some of the health concerns associated with livestock keeping

EXP2= the impact of the experience affecting daily life dealings in handling livestock health concerns

EXP3= the impact of the experience influencing the individual with the idea of keeping livestock or living close to where livestock are kept

Table 5-49: Total Variance Explained of Retained Items, Rotated Factor Loadings and Eigenvalues for Nine Perceived Risk Attribute Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.620	17.111	17.111	4.620	17.111	17.111
2	2.838	10.511	27.623	2.838	10.511	27.623
3	2.155	7.981	35.604	2.155	7.981	35.604
4	1.788	6.622	42.226	1.788	6.622	42.226
5	1.537	5.691	47.917	1.537	5.691	47.917
6	1.342	4.970	52.887	1.342	4.970	52.887
7	1.276	4.727	57.615	1.276	4.727	57.615
8	1.245	4.611	62.225	1.245	4.611	62.225
9	1.083	4.012	66.237	1.083	4.012	66.237

Extraction Method: Principal Component Analysis.

Table 5-50: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.794	.792	27

Table 5-51: Bartlett and KMO Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.668
Bartlett's Test of Sphericity	Approx. Chi-Square	1240.673
	Df	351
	Sig.	.000

Table 5-52: Principal Component Analysis and Factor Loadings of Potential Benefits Derived from Keeping Livestock

Rotated Component Matrix (b)

	Component		
	FAC2_1	FAC2_2	Communality
Economic Benefit_1	.782		.611
Economic Benefit_2	.736		.548
Social Benefit	.676		.531
Nutritional Benefit		.613	.575
Cultural Benefit		.834	.698
Environmental Benefit		.728	.541
Economic Benefit_3	.689		.558

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
b. Rotation converged in 3 iterations.

Notes:
ECONOMIC BENEFIT_1= Economic benefit derived from keeping livestock;
ECONOMIC BENEFIT_2= Economic benefit derived from selling livestock product;
ECONOMIC BENEFIT_3= Economic benefit derived as source of income from keeping livestock;
ENVIRONMENTAL BENEFIT= Environmental benefit by feeding livestock animals with household wastes

Table 5-53: Principal Component Analysis and Factor Loadings of Perceived Importance of Keeping Livestock

Rotated Component Matrix (c)

	Component		
	FAC3_1	FAC3_2	Communality
Food security Importance		.874	.781
Cash income Importance	.919		.846
Sustainability Importance	.879		.787
Household Animal Food Source Importance		.875	.783
Employment Importance	.702		.553

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
c. Rotation converged in 3 iterations.

5.6 Respondents' Views on Health Risk Reduction Preferences and Attitudes

In order to achieve part of objective (iv) of our study, this section presents chi-squared tests on views of respondents' differing risk preferences (WTP) and attitudes towards health risk reductions associated with livestock keeping. The results from this analysis is presented in (Table 5-54) and then summarized. Out of a total of 309 respondents interviewed, there was a shortfall of 60 questionnaires that these attitudinal questions were either not filled or respondents do not keep livestock to respond adequately to the question. This section of the study therefore utilizes data from 249 respondents that kept livestock and the remaining sixty questionnaires were used for socio-demographic and descriptive statistics only. This non-response poses a limitation to our study and inability to adequately assess the risk perception views of those not keeping livestock toward health concerns being studied.

The analysis in this section focused on the contingent market scenarios created to elicit respondents WTP via a weekly fee being charged by the city authority to provide some basic environmental services. The valuation mechanism was introduced to respondents via the provision of two hypothetical situations relating to livestock wastes (manure) produced as result of livestock keeping activity in the vicinity. The relevant payment vehicle was introduced to households via a discrete response payment principle question. Households which responded positively to the payment principle question were then asked about their maximum WTP to provide the proposed service.

Table 5-54 shows the results of cross tabulating respondents' agreement with the risk preference statement of willingness-to-pay for health risk reduction associated with livestock keeping activities and the various socio-demographic variables. A Chi-square test was used to test the significant difference of proportions of respondents that responded "Yes" or "No" to the statement and the influence of respondents' socioeconomic characteristics in making such a decision. From the result of the cross tabulation, the chi-square tests conducted show that the respondent's household location, marital status and ownership of the house lived are significant variables that influence this decision.

Table 5-55 shows the results of cross tabulating respondents' decision to keep livestock in their households and the various socio-demographic variables. A Chi-square test was also used to test the significant difference of proportions of respondents that "keep livestock" and those that "do not keep" and the influence of socioeconomic characteristics in making such decision. From the result of the cross tabulation, the chi-square tests conducted show that the respondent's age, number of children living in the household, marital status, educational status, household location, ownership of livestock and the house lived in, sources of water, household size and years lived in the present community are all significant variables that influence making such a decision.

Table 5-54: Frequency Distribution of Willingness-To-Pay for Health Risk Reductions by Respective Socioeconomic Variables with Statistically Significant Coefficients

SOCIOECONOMIC VARIABLES	"YES", WTP (%)	"NO", WTP (%)	DON'T KNOW (%)	CHI-SQUARE	P-VALUE
Age Category				**4.943^{NS}**	**0.551**
15-24yrs	66.0	4.3	29.8		
25-34yrs	72.7	8.0	19.3		
35-44yrs	68.6	12.9	18.6		
45yrs and over	65.2	10.9	23.9		
Household Location				**11.16****	**0.025**
Rural area	78.4	5.9	15.7		
Peri-urban area	58.9	8.4	32.6		
Urban area	72.3	11.6	16.1		
Gender				**1.916^{NS}**	**0.384**
Male	71.0	7.7	21.3		
Female	64.0	12.4	23.6		
Employment Status				**3.836^{NS}**	**0.699**
Public Officer	64.2	13.2	22.6		
Self-employed	70.7	10.6	18.7		
Student	70.3	2.7	27.0		
Others	69.0	10.3	20.7		
Educational Status				**2.023^{NS}**	**0.731**
Primary/Secondary	69.1	9.9	21.0		
Post-secondary/tertiary	66.4	9.8	23.8		
No formal/koranic	78.6	3.6	17.9		
Income Category				**4.972^{NS}**	**0.083**
Low	71.1	7.4	21.6		
Medium	59.3	16.7	24.1		
Marital Status				**5.936****	**0.05**
Never Married/Single	69.0	4.0	27.0		
Married/separated/divorced	68.2	12.2	19.6		
Number of Children				**2.078^{NS}**	**0.721**
No Child	71.4	2.9	25.7		
1-4 children	69.2	10.0	20.8		
More than 4 Children	68.4	10.2	21.4		
Ownership of House				**20.746*****	**0.000**
Owned by someone in the household	68.7	11.5	19.8		
Rented for cash	79.5	5.7	14.8		
No cash payment	42.1	10.5	47.4		
Household keeping livestock				**1.345^{NS}**	**0.510**
Yes, keep livestock	69.7	9.2	21.1		
No, do not keep livestock	60.0	10.0	30.0		

Source: Field Survey, December 2005-February 2006

The symbols (*), (**) and (***) denote statistically significant at the 10-, 5- and 1- percent levels of probability, respectively. NS means not statistically significant

Table 5-55: Cross Tabulations of Respondents' Decision to Keep Livestock in their Households and Socio-Demographic Characteristics with Statistically Significant Coefficients

VARIABLES	KEEP LIVESTOCK	DON'T KEEP LIVESTOCK	CHI-SQUARE[25]	P-VALUE
	-----Percentages-----			
AGE CATEGORY				
< 25yrs	74.2	25.8		
25-34yrs	75.7	24.3		
35-44yrs	86.6	13.4		
45yrs & above	92.2	7.8.	9.652**	0.022
GENDER				
Male	81.3	18.7		
Female	79.3	20.7	0.192^{NS}	0.662
INCOME CATEGORY				
Middle	81.3	18.8		
Low	80.4	19.6	0.023^{NS}	0.880
NUMBER OF CHILDREN				
No Child	55.1	44.9		
1-4 children	85.2	14.8		
More than 4	88.6	11.4	27.721***	0.000
MARITAL STATUS				
Married	86.2	13.8		
Never married	74.2	25.8	6.847**	0.009
EDUCATION STATUS				
Primary	86.3	13.7		
Post-secondary	75.6	24.4		
No formal	92.9	7.1	7.549**	0.023
OWN LIVESTOCK				
Husband/wife	100	0.0		
Other members	94.6	5.4	10.036***	0.002
HOUSEHOLD LOCATION				
Rural	100	0.0		
Peri-urban	78.6	21.4		
Urban	75.5	24.5	15.113***	0.001
HOUSEHOLD SIZE				
1-5 persons	56.9	43.1		
6-8 persons	87.3	12.7		
9-10 persons	91.2	8.8		
More than 10 persons	89.3	10.7	36.276***	0.000
EMPLOYMENT STATUS				
Public Officer	87.7	12.3		
Self-employed	81.2	18.8		
Student	70.6	29.4		
Others	78.8	21.2	5.158^{NS}	0.161
WATER SOURCE				

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[25] The result shown here is the Pearson Chi-square test for these variables and their significant levels

VARIABLES	KEEP LIVESTOCK	DON'T KEEP LIVESTOCK	CHI-SQUARE[25]	P-VALUE
Well/borehole	90.4	9.6		
Public/private tap	71.1	28.9		
Tap/well/borehole	88.9	11.1		
Others	100	0.0	19.160***	0.000
YEARS LIVED				
< 1 yr	33.3	66.7		
1-20 yrs	79.1	20.9		
21-40 yrs	97.6	2.4		
41-60 yrs	100	0.0	19.115***	0.000
OWN HOUSE				
Own by self or by someone	89.9	10.1		
Rented for cash	64.9	35.1		
Occupied with no cash payment	90.0	10.0	28.422***	0.000

Source: Own Computations; The symbols (*), (**) and (***) denote statistically significant at the 10-, 5- and 1- percent levels of probability, respectively. NS means not statistically significant

5.7 Chapter Summary

Through the factor analysis, it was revealed that nine underlying factors affect perceptions of risk associated with livestock keeping at the study location- FAC1_1 – *Severity Factor*, FAC1_2- *Environmental Factor;* FAC1_3-*Control Factor;* FAC1_4- *Knowledge Factor*, FAC1_5-*Unnamed Factor, FAC1_6-Awareness Factor, FAC1_7 – Involuntary Exposure Factor; FAC1_8-Experience Factor, FAC1_9-Unnamed Factor (Table 5-48).* The Severity dimension includes variables such as the consequences of a zoonotic disease leading to death, health risk from livestock wastes/dust/smell from poor housing to be fatal and death resulting from consumption of contaminated animal food products and application of animal wastes to farmlands. *The Environmental Factor* includes control of environmental pollution from animal wastes and control of exposure to poor livestock housing and poor management of livestock wastes.

The factor analysis conducted on the perceived benefits derived by households from keeping livestock also revealed that two underlying factors motivate members of household to make such decisions. The two factors revealed are a mixture of Economic/Social benefits (FAC2_1) and a mixture of Cultural/Environmental Benefits (FAC2_2). Also in measuring the importance of these potential benefits to households, a separate factor analysis revealed that two underlying dimensions are also responsible for this motivation. The two factors revealed are recoded *Livelihood Strategy or Income*

Smoothing Factor (FAC3_1) and Food Security or Consumption Smoothing Factor (FAC3_2).

In summary, all analyses conducted on the psychometric scales used for this study such as the factor structure, reliability, and validity of all scale items were confirmed. To also assess the importance of using PCA in this research, the Kaiser-Meyer-Olkin (KMO) statistic was computed and the Bartlett test was performed (Bartlett 1937). The KMO statistic is a ratio that ranges from 0 to 1 and for any PCA to be within the acceptable range, this statistic should be at least 0.7. Based on this criterion, quite a few scales passed this criterion but the Bartlett tests of the correlation matrix among the variables were all significantly different from the identity matrix (i.e. null hypothesis was rejected). Also the resulting dimensions (also called principal components), have moderately good Cronbach's alpha coefficients and higher factor loadings, which means the scales observe both the validity and dimensionality criteria (Hair et al., 1995).

6.0 CHAPTER SIX: *MODEL SPECIFICATION, ESTIMATION AND RESULTS*

6.1 Introduction

In this chapter, several econometric models of respondents' decision to keep livestock and willingness-to-pay for health risk reductions are estimated. Section 6.2 is a detailed description of the model variables. Section 6.3 is the estimation procedure and it shows the model selection, specification and an analytical step used in estimating the empirical models. In section 6.4 the estimated results and coefficients are presented in tables to show the statistically significant variables and other statistical parameters. The preferred models are then chosen on the basis of economic and statistical considerations. In section 6.5, the empirical results of the three preferred models are discussed. Tests for validity of the models are presented and the final chapter summary is presented in section 6.6.

6.2 Definition of Model Variables

6.2.1 Description of Dependent Variables

In the present study, the basic model applied is a variant of the random utility model in Equation (3.1) and is the simplest probability model. Two behavioural choice models are developed; the first model specified (Equations 6.1 and 6.2) represents the binary-choice model of the decision to keep livestock or not. The model is used to estimate the probability of decision of respondent's household to keep livestock and determine socio-demographic factors that influenced such decision. The second model (Equations 6.3 and 6.4) is to estimate the willingness-to-pay for reduction of identified health risks associated with keeping livestock. The dependent variable in each model has only two categories in each response variable. The dependent variable is specified with a 0-1 dummy variable by specifying a "0" response which implies that a respondent did not keep livestock in his/her household or is not WTP for any risk reduction intervention being proposed while "1" represents the opposite decision made by the respondent. The probabilities corresponding to the two categories of response variables were computed using the following formulae:

The probability of an individual responding "Yes" to keeping livestock is:

$$\Pr(Y_{KPL}=1) = \frac{EXP(\alpha_1 + \sum_{i=1,2...}\beta_i X_i)}{1 + EXP(\alpha_1 + \sum_{i=1,2...}\beta_i X_i)} \tag{6.1}$$

The probability of an individual responding a "No" to keeping livestock is:

$$\Pr(Y_{KPL}=0) = \left(\frac{\exp(\alpha_2 + \sum_{i=1,2...}\beta_i X_i)}{1+\exp(\alpha_2 + \sum_{i=1,2...}\beta_i X_i)}\right) - \left(\frac{\exp(\alpha_1 + \sum_{i=1,2...}\beta_i X_i}{1+\exp(\alpha_1 + \sum_{i=1,2...}\beta_i X_i}\right) \tag{6.2}$$

The probability of an individual responding "Yes" to WTP for health risk reductions:

$$\Pr(Y_{WTP}=1) = \frac{EXP(\delta_1 + \sum_{i=1,2...}\lambda_i Z_i)}{1 + EXP(\delta_1 + \sum_{i=1,2...}\lambda_i Z_i)} \tag{6.3}$$

The probability of an individual responding a "No" to WTP:

$$\Pr(Y_{WTP}=0) = \left(\frac{\exp(\delta_2 + \sum_{i=1,2...}\lambda_i Z_i)}{1+\exp(\delta_2 + \sum_{i=1,2...}\lambda_i Z_i)}\right) - \left(\frac{\exp(\delta_1 + \sum_{i=1,2...}\lambda_i Z_i}{1+\exp(\delta_1 + \sum_{i=1,2...}\lambda_i Z_i}\right) \tag{6.4}$$

Where α_i *and* β_i; are intercepts and coefficients; and X_i the independent variables included in the first model and where δ_i *and* λ_i; are the intercepts and coefficients and Z_i the independent variables included in the second model.

The following dependent variables are used for analyses in this study to achieve three of the major objectives stated in earlier chapters. In order to model the decision of households to keep livestock **(KPLVST)** or not and the socio-economic determinants of the choice made, a binary choice dependent variable is specified. The second dependent variable used in this study analysis is the willingness-to-pay **(WTP)** for health risk reductions which is specified as a binary variable. In modeling respondents' attitudes and perceptions towards health risks associated with livestock keeping, a proxy variable

"Overall perceived riskiness" **(OVERISKY)** is specified as a binary dependent variable. This is expresses the degree of riskiness associated with livestock keeping as perceived by the households. A summary definition of all these variables is presented in Table 6-1.

6.2.2 Description of Independent Variables

The explanatory variables included in the analysis are selected based on a non-parametric correlation analysis performed on these variables and their levels of association with each other (refer to table in section 5.2).

The first set of explanatory variables is related to the livestock keeping decision of households with individual and household specific characteristics as revealed in the sample data. **HHLOC** is an independent variable with three possible categories. The variable shows the metropolitan location of the respondent's household, which could be located in the rural, peri-urban or urban location. **GENDER** is a self-explanatory dummy variable of 1 if the respondent is male and 0 if otherwise. **AVEAGE**[26] is the mean age category in which an individual belongs during the survey period. **EDUST** is the level of education the respondent claimed to have. The education variable has four categories with no formal education as the lowest and a University degree as the highest educational level a respondent could attain.

MARST is the marital status dummy variable for a respondent who is married which takes the value of 1 and 0 if otherwise. **EMPLST** is a variable with four categories of employment type. The first category are public officers; the second category are those working in private company on a part-time or full-time basis or student group; the third category are self-employed such as traders, farmers or those not in the wage group; and the fourth category are retired officers from public service. **YRSLVD** specified as a dummy variable of the number of years that the respondent has lived in his/her present house or community.

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[26] In the survey, age was recorded by age category. Rubinfeld's (1977, p.33) method in constructing income variable was adopted by "assigning to each individual category the midpoint of the range of possible response.

HHSIZE is also a dummy variable that represent number of people living in the respondent's household. **NOFCHD** is a dummy variable representing the number of children living in the household who are less than 18 years. **OWNHOU** is a dummy variable relating to the ownership of the house where the respondent lives at the time of the survey. A respondent is assigned 1 if s/he owns the house and 0 if otherwise. **OWNLVST,** ownership of livestock kept in the household, a dummy variable of 1 is assigned if the head of the household (male or female-headed) or both own the livestock and 0 if otherwise. **INCCAT** is the income category variable that is derived from combinations of instrumental variables where a respondent could belong to a middle or low-income household. **LVSTYP** this is the type of livestock kept in the respondent's household. Six major types of livestock are identified as being kept by respondents.

The second set of explanatory variables is related to general risk perception and attitudinal information of the respondent. These variables were included to determine the effect of individual's attitudes and risk perceptions. The factor scores derived from the factor analysis of these variables are also used to assess respondents' decision concerning WTP for health risk reductions. **WTP** is the dependent variable used in our analysis to estimate the probability of respondents' willingness to pay for health risk reductions associated with keeping of livestock in their households. This is a limited dependent variable with the value of 1 if the respondent expresses a positive (yes) WTP and 0 if otherwise. **FAC** is the set of factor scores for each perceived risk attributes of all the identified human and environmental risks associated with keeping of livestock. **AVPERBEN** is the average score of all benefits that respondents perceived they derive from keeping livestock in their households. **IMPTCE** is a dummy variable assigned the value of 1 for the situation where benefits derived are perceived to be very important to the household and 0 if otherwise. This variable shows the relative importance a respondent assigned to benefits derived from keeping livestock.

Table 6-1: Operational Definitions of Dependent and Independent Variables

INDEPENDENT VARIABLES	DESCRIPTION OF VARIABLE
EDUST_1	= 1 if respondent 's level of education is below high school; else 0 if otherwise
EDUST_2	= 1 if respondent has some post-secondary education; else 0 if otherwise
EDUST_3	= 1 if respondent has a college degree or above; else 0 if otherwise
GENDER	= 1 if respondent is a male; else 0 if otherwise
AVEAGE	= Mean age of respondent in each age category
HHSIZE_1	= 1 if respondent household has 1-5 persons; else 0 if otherwise
HHSIZE_2	= 1 if respondent household has more than 5 persons; else 0 if otherwise
YRSLVD	= 1 if respondent has lived in the house for more than a year; else 0 if otherwise
EMPLST_1	= 1 if respondent is unemployed; else 0 if otherwise
EMPLST_2	= 1 if respondent is self-employed; else 0 if otherwise
EMPLST_3	= 1 if respondent is employed in public service; else 0 if otherwise
MARST	= 1 if respondent is married; else 0 if otherwise
HHLOC_1	= 1 if respondent household is located in the urban area; else 0 if otherwise
HHLOC_2	= 1 if respondent household is located in the peri-urban area; else 0 if otherwise
HHLOC_3	= 1 if respondent household is located in the rural area; else 0 if otherwise
OWNHOU	= 1 if respondent owns the house lived in; else 0 if otherwise
LVSTYP	= 1 if livestock kept is poultry; else 0 if otherwise
NOFCHD	= 1 if respondent has children in the household; else 0 if otherwise
INCCAT	= 1 if respondent is in low-income group; else 0 if otherwise
IMPTCE	= 1 if benefit is very important; else 0 if otherwise
AVPERISK	= Average of the scores on perceived risk associated with livestock keeping
AVPERBEN	= Average of the scores on perceived benefits derived from keeping livestock

Source: Field Survey, December 2005-February 2006

DEPENDENT VARIABLES	DESCRIPTION OF VARIABLE
KPLVST	= 1 if respondent kept livestock; else 0 if otherwise
WTP	= 1 if respondent said 'YES' to 'WTP'; else 0 if otherwise
OVERISKY	= 1 if overall perceived risk is 'risky'; else 0 if otherwise

6.3 Estimation Procedure

In specifying the estimation model used in this study, the theoretical framework as discussed in chapter 3 was followed to achieve objectives (i) and (iii). The binary logit model is selected and preferred to the probit model because it does not require assumption of the error terms to be jointly and normally distributed. Since the choice in this study is binary and can only take positive values (0, 1), violating the assumption of a normal distribution is therefore not a specification concern. Both **SHAZAM** and **SPSS** statistical software packages are used to conduct the analyses. The general model is specified as a logarithmic ratio of the choice probability in equation (6.5):

$$(p) = Ln\left[\frac{p}{1-p}\right] = \sum_{k-1}^{k} \beta_k x_k \qquad (6-5)$$

The logarithm of the odds (that is probability, *p*, divided by one minus the probability, *p*) of the outcome is modeled as a linear function of the explanatory variables, X_1 to X_k, as shown in Equation (6.6):

$$Ln\left[\frac{P_r(Y_i = 1)}{1 - P_r(Y_i = 1)}\right] = \alpha + \beta_1 x_{1,i} + \beta_2 x_2 + \ldots + \beta_k x_{k,i} \qquad (6-6)$$

$i, = 1, \ldots n$, *where* $p = \Pr(Y_i = 1)$

The empirical model for this study consists of two categories of exogenous variables in which each category tries to address a particular study objective. The first category of variables includes socio-demographic factors such as age, gender, household location; household size, education, marital status and income category just to mention a few in achieving the first objective. The second category of variables includes respondents' household general attitudinal and perceived risk characteristics. These two categories of factors are combined in the conceptual model specified in Figure 3-1 in estimating the empirical models of individual households' optimal decision-making processes.

6.3.1 Model Selection

In this section, the empirical results from estimating the potential influences of respondents' socioeconomic and demographic characteristics on decision to keep livestock are analyzed in Model group 1 (Table 6-2) with four sub-models. The measurement of the dependent variable is based on the response from the livestock keeping decision, since the response is a dichotomous variable: 'keep' or 'not keep; as a result, a logistic regression is implemented. The exogenous variables in this model include respondents' gender, age, squared form of age, household location, educational level, marital status[27], household size, number of years lived in the household or community, number of children under 18years and household income category. Several of the previously discussed demographic variables were omitted in the final version of the model because of their insignificant estimated coefficients. All the exogenous variables are expressed as either binary or dummy variables with the exception of the age variable. The use of dummy variables for educational status, household size and numbers of years lived in the households may pose a limitation to this study. The sample mean age variable was constructed by assigning to each individual category the midpoint of the range of possible response.

In order to correct for multicollinearity problems among these variables, different restrictions are tested to decide the best predictive model. For the selection of the final model, several different techniques are applied to the estimated coefficients to test their significance for inclusion or elimination from the model. A series of regressions were conducted in which a full or saturated model was first specified which included all the socio-economic, demographic and attitudinal variables. Variables are eliminated from the model in an iterative process. The fit of the model is tested after the elimination of each variable to ensure that the model still adequately fits the data. Likelihood ratio tests were conducted to estimate the importance of the inclusion of the respective variables in the final models. The model with the highest log likelihood ratio is selected as the final model and the discussion that follows in the next section is based on this final model. The null hypothesis for this test statistic is asymptotically distributed as chi-square with degrees of freedom equal to the number of variable restrictions to be tested (Green 1993). The calculated chi-square statistics for each model is compared with the critical value at 5% confidence interval on the chi-square table distribution for each corresponding degree of freedom. Four sub-models of each basic model were then specified and estimated and parameter estimates of all these models are summarized in Appendix (A2).

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[27] Marital status was highly correlated with the age variable so this was dropped in the final analysis since the estimated parameter for this variable was insignificant in other sub-models.

6.3.2 Model Specification

The indirect utility function specified in equation 3.6 (V_{iq}) for household q^{th} for making a choice i is specified for each of the basic models to achieve objective (i) and (iv) as specified in equations (6-7 and 6-8). A logistic regression analysis was adjusted to estimate the overall perceived riskiness of keeping livestock by households as specified in equation (6-9) below.

Model Group1 KPLVST: Household Decision to Keep Livestock

$$\begin{aligned}&Keep\ Livestock\ decision = \alpha_0 + \alpha_{1i}Gender + \alpha_{2i}AVEAGE + \alpha_{3i}MARST\\&+ \alpha_{4i}EDUST + \alpha_{5i}EMPLST + \alpha_{6i}HHSIZE + \alpha_{7i}YRSLVD + \alpha_{8i}NOFCHD\\&+ \alpha_{9i}OWNHOU + \alpha_{10i}LVSTYP + \alpha_{11i}INCCAT + \alpha_{12i}HHLOC\\&+ \varepsilon_{iq}\end{aligned} \tag{6-7}$$

Model Group2 WTP: Household Willingness-to-Pay Decision for Health Risk Reduction

$$\begin{aligned}&YES\ WTP decision = \beta_0 + \beta_{1a}Gender + \beta_{2a}AVEAGE + \beta_{3a}MARST\\&+ \beta_{4a}EDUST + \beta_{5a}EMPLST + \beta_{6a}HHSIZE + \beta_{7a}YRSLVD + \beta_{8a}NOFCHD\\&+ \beta_{9a}OWNHOU + \beta_{10a}LVSTYP + \beta_{11a}INCCAT + \beta_{12a}AVPERBEN + \beta_{13a}IMPTCE + \beta_{14a}HHLOC\\&+ \beta_{15a}AVPERISK + \beta_{16a}\sum\nolimits_{an}FAC + \varepsilon_{aj}\end{aligned} \tag{6-8}$$

Model Group3 OVERISKY: Overall Perceived Riskiness of Keeping Livestock

$$\begin{aligned} &OVERISKY = \lambda_0 + \lambda_{1i} Gender + \lambda_{2i} AVEAGE + \lambda_{3i} MARST \\ &+ \lambda_{4i} EDUST + \lambda_{5i} EMPLST + \lambda_{6i} HHSIZE + \lambda_{7i} YRSLVD + \lambda_{8i} NOFCHD \\ &+ \lambda_{9i} OWNHOU + \lambda_{10i} LVSTYP + \lambda_{11i} INCCAT + \lambda_{12i} AVPERBEN + \lambda_{13i} IMPTCE + \lambda_{14i} HHLOC \\ &+ \lambda_{15i} AVPERISK + \lambda_{16i} \sum\nolimits_{im} FAC + \varepsilon_{iq} \qquad (6-9) \end{aligned}$$

For equations (6-7 to 6-9), α_i β_i and λ_i represent the respective vectors of coefficients for the explanatory variables for each of the i choice of response (where $i = 1$ or 0) for all the three binary logit models specified. The results of the estimated coefficients and their corresponding t-statistics (giving the choice probabilities at means) for each of the models tested are presented in Tables 6-3 to 6-5. A full model result of each model can be seen in Appendix (A2). The reduced versions of the models were assessed to rule out any possible effect of collinearity with no significant difference in the results.

Table 6-2: Different Variations of the Final Model Specification

Main Model	Sub-model	Dependent Variable	Explanatory Variables Included
Model Group 1	Model 1: 1	Determinants of Household Decision to Keep Livestock	Socio-demographic variables with no household income category but mean age squared of respondent included
	Model 1: 2		Socio-demographic variables with no marital status but mean age of respondent included
	Model 1: 3		Socio-demographic variables with no marital status, no education and no number of children but mean age squared of respondent included
	Model 1: 4		Socio-demographic variables with all variables but mean age squared of respondent included
Model Group 2	Model 2: 1	Determinants of WTP for Health Risk Reductions	Socio-demographic variables with livestock type and benefit derived from livestock included but education and marital status excluded
	Model 2: 2		Socio-demographic variables with livestock type and importance of livestock included.
	Model 2: 3		Socio-demographic variables with no marital status, no education and no number of children but mean age squared of respondent, ownership of livestock and perceived risk included
	Model 2: 4		Socio-demographic variables with all variables but livestock type, perceived risks and benefits included
Model Group 3	Model 3: 1	Risk Attitudes and Perception	Include all factors from the PCA analysis with some selected socio-demographic variables
	Model 3: 2		Include all factors except the benefit factor from the PCA analysis with some selected socio-demographic variables
	Model 3: 3		Include all factors except the factors from the importance of all livestock with some selected socio-demographic variables
	Model 3: 4		Include all factors from PCA analysis and the type of livestock kept with some selected socio-demographic variables

6.4 Discussion of Results

The three groups of models specified in the earlier section of this chapter were all treated as binary logit models. The models were estimated using econometrics software SHAZAM professional edition version. In each of the models estimated, results of the logistic regression are discussed mainly by focusing on the statistical significance of each of the independent variables. Following these discussions are a brief explanation of the predicted probabilities and their relevance to the models. The results from the log-likelihood ratio test indicate that the selected estimated models were statistically valid. The values of the pseudo R-square also indicate acceptable goodness-of-fit of the model. Choosing the model with the largest R-square in each of the three groups, shows that our model final selection does adequately fit the data.

Three major objectives of this study are to determine and predict the probabilities on how household member make decisions in their households by (i) determining the socioeconomic and demographic factors influencing the decision of household members to keep livestock; (ii) assessing the overall perceived human and environmental health risks associated with livestock keeping and (iii) determining factors that influence the willingness to pay for health risk reductions associated with keeping livestock in their neighbourhood. These and other objectives are the driving forces for this study and further analyses conducted. The reported results and discussion that follow in this section are based on the estimated coefficients for the three groups of model specified in section 6.3.2 to achieve the respective objectives.

6.4.1 Socio-demographic Determinants of Household Decision to Keep Livestock

In model group 1, seven (7) socio-demographic variables are used as explanatory variables to explain respondents' probability of keeping livestock. The final model (Model 1-4) includes alternative-specific constant, gender, age, household location, household size, number of years lived in the household, number of children under 18 years of age and household income category. In all the sub-models, the coefficients on household location and size are all statistically significant which implies the inclusion of the two variables in our final model is expected and relevant in explaining respondent's household decision to keep livestock.

Table 6-3: Logistic Regression Estimates of Socio-Demographic Determinants of Households' Decision to Keep Livestock

VARIABLE	MODEL 1: 1	MODEL 1: 2	MODEL 1: 3	MODEL 1: 4
CONSTANT	0.95914 (0.519)	0.8926 (0.835)	1.2608 (0.5802)	1.0612 (0.954)
MALE	0.24831 (0.338)	0.2192 (0.339)	0.1555 (0.333)	0.2307 (0.34)
AGE SQUARED	0.421E03 (0.43E03)	N.A.	**0.758E03**** (0.320E03)	N.A.
AVERAGE AGE	N.A.	**0.378E01*** (0.216E01)	N.A.	0.249E01 (0.289E01)
PERIURBAN	**0.7380**** (0.336)	**0.7565**** (0.337)	**0.7514**** (0.333)	**0.7667**** (0.338)
MARITAL	0.32232 (0.445)	N.A.	N.A.	0.3559 (0.458)
HOUSEHOLD SIZE	**-1.2790***** (0.369)	**-1.3728***** (0.363)	**-1.6485***** (0.343)	**-1.3833***** (0.379)
EDUCATION STATUS	0.1461 (0.381)	N.A.	N.A.	0.1949 (0.385)
YEARS LIVED	-1.4872 (0.986)	-1.5591 (1.061)	-1.6079 (1.041)	-1.5394 (1.0324)
NO OF CHILDREN	**-0.7928*** (0.412)	**-0.8716**** (0.405)	N.A.	**-0.7645*** (0.418)
INCOME CATEGORY	N.A.	-0.5340 (0.417)	-0.5827 (0.415)	-0.5648 (0.421)
Log-likelihood function	-121.81	-121.34	-123.46	-120.89
Restricted Log-likelihood function	-146.29	-146.29	-146.29	-146.29
Chi-Square (χ^2) Likelihood Ratio Test	48.9536 (DF=8)	49.8941 (DF=7)	45.6511 (DF=6)	50.7950 (DF=9)
Adjusted ρ^2	0.1446	0.1508	0.1389	0.1481
% Predicted correct	81.46%(246)	82.11% (248)	82.78%(250)	81.79%(247)
McFadden R^2	0.1673	0.1705	0.1560	0.1736

Notes: (Standard Errors in Parentheses); the symbols (*), (**) and (***) denote statistically significant at the 10-, 5- and 1- percent levels of probability, respectively. N/A denotes independent variable not included in the specified subgroup model.

6.4.2 Determinants of Willingness-To-Pay (WTP) for Health Risk Reduction

Model 2-1 has 20 explanatory variables that were included in the model and 6 of these variables explained respondents' probability of willingness-to-pay to reduce health risks associated with livestock keeping. In Model group 2, the selected model (2.1) has relatively high correct predictions; it also has the highest log likelihood ratio (LR Test

Chi square) as well as the highest pseudo-R square (McFadden R-square). After a rigorous model testing accompanied by removal of each independent variable, one at a time, we found that no other model has better goodness-of-fit than model 2-1. For this reason and other statistically satisfactory explanations, this led to the final selection of this preferred model for analysis and further discussion in the next section.

Table 6-4: Logistic Regression Estimates of the Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping

VARIABLE[a]	MODEL 2: 1	MODEL 2: 2	MODEL 2: 3	MODEL 2: 4
CONSTANT	0.0078 (0.909)	**-2.2569**** (1.1416)	-2.3208 (0.6721)	-0.32508 (0.6036)
AGE SQUARED	0.50528E-02 (0.0090295)	N/A	**0.0091*** (0.0069)	N/A
AVERAGE AGE	N/A	0.02292 (0.02108)	N/A	0.0087 (0.0150)
MARITAL STATUS (2)	-0.38645 (0.33675)	-0.04878 (0.3540)	N/A	N/A
MALE	N/A	**0.8137***** (0.2674)	**0.8707***** (0.2639)	**0.6347***** (0.2518)
PERIURBAN	-0.44902 (0.29941)	N/A	N/A	N/A
URBAN	N/A	N/A	0.2185 (0.2689)	**-0.47798**** (0.2673)
POULTRY	**0.72662**** (0.32015)	N/A	**0.8941***** (0.3247)	N/A
PIGS	N/A	N/A	0.01782 (0.5940)	N/A
OVERALL PERCEIVED RISKINESS	N/A	-0.0245 (0.0425)	-0.1624 (0.2537)	N/A
AVERAGE PERCEIVED BENEFIT	N/A	**0.41497***** (0.1172)	-25.975 (0.50132E+06)	N/A
AVERAGE IMPORTANCE	N/A		26.296 (0.5013E+06)	
LIVESTOCK TYPES	N/A	N/A	**0.2624***** (0.0958)	0.00633 (0.0812)
EDUCATION STATUS	0.1011 (0.22293)	N/A	N/A	N/A
ACCTBID	0.6418E-03 (0.2386E-02)	N/A	N/A	N/A
NO OF CHILDREN (1)	N/A	0.7880 (0.7659)	N/A	N/A
NO OF CHILDREN (3)	N/A	0.4160 (0.7287)	N/A	N/A

VARIABLE*	MODEL 2: 1	MODEL 2: 2	MODEL 2: 3	MODEL 2: 4
NO OF CHILDREN (2)	N/A	0.32197 (0.7240)	-0.2144 (0.2551)	N/A
OWNHOUSE (1)	N/A	0.06377 (0.2554)	0.0.4920 (0.2638)	0.3440* (0.2477)
FAC1_1	0.17812 (0.1656)	N/A	N/A	0.02419 (0.1557)
FAC1_2	0.32272* (0.1677)	N/A	N/A	0.14536 (0.1571)
FAC1_3	0.08586 (0.171)	N/A	N/A	N/A
FAC1_4	-0.2544 (0.172)	N/A	N/A	0.08762 (0.1570)
FAC1_5	-0.2862** (-0.171)	N/A	N/A	N/A
FAC1_6	-0.07685 (0.1675)	N/A	N/A	0.2185* (0.1592)
FAC1_7	-0.0269 (0.1675)	N/A	N/A	N/A
FAC1_8	-0.4805*** (0.1822)	N/A	N/A	N/A
FAC1_9	0.4576*** (0.1685)	N/A	N/A	N/A
FAC2_1	0.5578*** (0.2129)	N/A	N/A	-0.1011 (0.1834)
FAC2_2	-0.0897 (0.1855)	N/A	N/A	-0.2039 (0.1683)
FAC3_1	-0.2117 (0.1869)	N/A	N/A	0.1345 (0.1736)
FAC3_2	0.14515 (0.1746)	N/A	N/A	0.3355** (0.1642)
Log-likelihood function	-179.14	-183.66	-182.88	-196.71
Restricted Log-likelihood function	-199.37	-197.68	-202.46	-206.11
Chi-Square (χ^2) Likelihood Ratio Test	40.45 (DF=20)	28.04 (DF=11)	39.16 (DF=11)	18.82 (DF=14)
% Predicted correct	65.75%(192)	65.40%(189)	69.93%(207)	61.9%(187)
McFadden R^2	0.10145	0.0709	0.0967	0.0456

Notes: (Standard Errors in Parentheses); the symbols *, **, ***, denote statistically significant coefficient at the 10-, 5- and 1-percent levels of probability, respectively.
N/A: Not all variables are included in the table above; the variables reported are those that show significant contribution to each of the specified models. A detailed explanation of all included variables and the full models are in appendix to chapter six (Appendix A2).

6.4.3 Determinants of Household Attitudes and Perception of Risks Associated with Livestock Keeping

Model 3-4 was selected for the analysis of the survey data because it has the highest correct predictions; it also has the highest log likelihood ratio (LR Test Chi square) and the highest pseudo-R square (McFadden R-square). After a rigorous model testing accompanied by removal of each independent variable, one at a time, we found that no other model has better goodness of fit than model 3-4. This led to the final selection of this model for analysis and further discussion will be based on it in this section.

Table 6-5: Logistic Regression Estimates of Respondents' Overall Perceived Risk and Attitudes toward Livestock Keeping

VARIABLE	MODEL 3: 1	MODEL 3: 2	MODEL 3: 3	MODEL 3: 4
CONSTANT	0.06393 (0.9115)	-0.3396 (0.8093)	-0.4368 (0.8280)	0.69812E-01 (0.7902)
AGE SQUARED	-0.8022E-03 (0.8786E-02)	N/A	N/A	N/A
AVERAGE AGE	N/A	0.01172 (0.02262)	0.0135 (0.0227)	0.1274E-02 (0.23292E-01)
MARITAL STATUS	-0.28568 (0.3433)	-0.09895 (0.3793)	-0.1129 (0.3802)	-0.25818E-01 (0.39275)
MALE	N/A	N/A	-0.1878 (0.2708)	-0.7727E-01 (0.2801)
PERIURBAN	-0.1325E-02 (0.3107)	0.0248 (0.2828)	0.0821 (0.2899)	-0.3338 (0.3062)
URBAN	N/A	N/A	N/A	0.3812 (0.2770)
POULTRY	0.04471 (0.3158)	N/A	N/A	0.1567 (0.3009)
PIGS	N/A	N/A	N/A	0.18679 (0.6185)
OWNHOUSE (1)	N/A	0.08483 (0.2731)	0.0879 (0.2744)	0.1251 (0.2872)
EDUCATION STATUS	0.1056 (0.2282)	0.1207 (0.2222)	0.1340 (0.2225)	0.2722 (0.2330)
NO OF CHILDREN (1)	-0.1244 (0.1998)	-0.1809 (0.3768)	-0.1746 (0.3778)	-0.1646 (0.4010)
INCCAT	N/A	-0.3447 (0.3356)	-0.3264 (0.3384)	-0.2222 (0.3293)
FAC1_1	**0.6919***** (0.1859)	**0.6528***** (0.1819)	**0.6482***** (0.1825)	**0.9796***** (0.2064)

VARIABLE	MODEL 3: 1	MODEL 3: 2	MODEL 3: 3	MODEL 3: 4
FAC1_2	**-0.3887****	**-0.3661****	**-0.4030****	**-0.3545****
	(0.1819)	(0.1721)	(0.1758)	(0.1904)
FAC1_3	0.2745	N/A	N/A	N/A
	(0.1831)			
FAC1_5	-0.0278	N/A	N/A	N/A
	(0.1770)			
FAC1_6	**0.6028*****	**0.5810*****	**0.5738****	**0.7820*****
	(0.1814)	(0.1760)	(0.1791)	(0.1934)
FAC1_7	0.1518	N/A	N/A	N/A
	(0.1722)			
FAC1_8	**0.2948****	N/A	N/A	N/A
	(0.1775)			
FAC1_9	-0.5280E-02	N/A	N/A	N/A
	(0.1751)			
FAC2_1	**0.4385****	**0.4002****	**0.3383****	**0.4743****
	(0.2191)	(0.19377)	(0.2839)	(0.2125)
FAC2_2	**-0.5621*****	**-0.4450*****	**-0.4479****	**-0.4917*****
	(0.2052)	(0.1905)	(0.1951)	(0.2035)
FAC3_1	0.1685	N/A	0.2022	0.0625
	(0.1987)		(0.1931)	(0.1995)
FAC3_2	-0.1485	N/A	-0.1037	-0.1084
	(0.1740)		(0.1696)	(0.1755)
Log-likelihood function	-172.14	-177.08	-176.36	-166.46
Restricted Log-likelihood function	-201.57	-201.09	-201.09	-201.42
Chi-Square (χ^2) Likelihood Ratio Test	58.85 (DF=19)	48.02 (DF=14)	49.44 (DF=16)	69.91 (DF=16)
% Predicted correct	71.23% (208)	69.07% (201)	68.04% (198)	70.10% (204)
McFadden R^2	0.14598	0.1194	0.1229	0.1735

Notes: (Standard Errors in Parentheses); the symbols (*), (**) and (***) denote statistically significant at the 10-, 5- and 1- percent levels of probability, respectively. N/A: Not all variables are included in the table above; the variables reported are those that show significant contribution to each of the specified models

6.5 Discussion on Estimated Coefficients of Explanatory Variables

Looking at the estimation results in Tables 6-3 to 6-5, it is seen that many of the estimates (those in bold) are statistically significant at 1, 5 and 10 percent levels for each model estimated. Three models focusing on our key research objectives were selected for further discussion: Model 1.4 from Group 1, Model 2.1 from Group 2, and Model 3.4 from Group 3. In each of the models estimated, the results of the logistic regression are discussed mainly by focusing on the statistical significance of each of the independent variables. In each of the models, marginal effects to measure the magnitude of the effects of a 'marginal', i.e. a one unit ceteris paribus, change in the explanatory variable on the probability of the dependent variable. For our choice model, it requires partially differentiating the probability of the event with respect to the explanatory variable.

6.5.1 Estimated Results and Effects of Socio-Demographic Factors on Household Decision to Keep Livestock

Model 1-4 is the binary response logit model selected from Table 6-3 to examine the socioeconomic and demographic factors underlying respondents' choice whether or not to keep livestock. In model 1-4, there are three statistically significant explanatory variables as well as desirable statistical properties (high chi-square value of the Likelihood ratio test and also the high value of the R-square). The results show that three variables; "HOUSEHOLD SIZE", "PERIURBAN LOCATION" and "NO OF CHILDREN" contributed significantly to the specified model. The estimated coefficient on the number of household members (HOUSEHOLD SIZE) is negative and statistically significant at 99 percent confidence level. The highly significant negative coefficient of the household size indicates that the likelihood of a respondent to keep livestock in their household decreases for a respondent with fewer members in the household. This finding therefore seems to confirm studies by (Siegmund-Schultze et al. 2000) and (Siegmund-Schultze and Rischkowsky 2001), that keeping small ruminants (sheep) in West Africa was related to the size of the household.

The variable household location "PERIURBAN" has a positive and significant coefficient at the 95 percent confidence level showing that respondents with households located in the peri-urban areas were more likely to keep livestock than those located in the urban or rural areas. The estimated coefficient of the number of children under 18 years of age, "NO OF CHILDREN", is also negative and significant at 95 percent confidence level, indicating that respondents with children less than 18 years in the households were less likely to keep livestock than those with more matured children. The interpretation of this is that an average respondent, who lives in a household located in the peri-urban area, has children over 18 years of age, and whose total household size is more than four members, is more likely to keep livestock within the household.

Surprisingly, some of the a priori socioeconomic and demographic variables like age, gender, educational status and income level of the household do not have any statistically significant effect on this choice response. As expected, however, household size and presence of children are some of the commonly expected variables that influence such household decisions. Despite the fact that in Model 1-2, more variables show some level of significant contribution to the model, this model was not selected as our final model because of its low pseudo R-squared value (0.1705) and the Likelihood ratio test. The variable AVGAGE showed up in this model as a contributing factor but at a very low level of significance and dropping it in the final model 1-4 improves the goodness-of-fit of this latter model. The goodness-of-fit of estimation is further evident in the model's ability to predict the respondent actual choice correctly by 81.8 percent of the time.

6.5.2 Estimated Results and Effects of Socio-economic and Risk Characteristics on the Willingness-To-Pay for Health Risk Reduction Associated with Livestock Keeping

Table 6-4 shows the results of the logistic regression model that examined the determinants of household WTP for health risk reduction associated with livestock keeping. The results in the final selected model (Model 2-1) include an alternative-specific constant, and some factors from the results of the PCA conducted in section 5-5 of the previous chapter. This model was selected as our final model because of its high R-squared value (0.1015) and the highly significant chi-square statistic in Table 6-4. The goodness-of-fit of estimation is further evident in the model's ability to predict the respondent's actual choice correctly by 65.8 percent of the time.

Some socioeconomic factors that were expected to be statistically significant were not. Surprisingly, in the chosen model, none of the socio-demographic factors included were statistically significant. Factors identified to influence the willingness-to-pay choice with discriminating power are six and this includes five of the identified underlying risk attributes (characteristics) associated with perception of risk from the result of our PCA.

The estimated coefficients of these factors showed a range of levels of confidence from significant to highly significant. The statistically significant factors are Environmental Factor (FAC1_2), Catastrophic Factor (FAC1_5), Economic/Social Benefits Factor (FAC2_1), Experience Factor (FAC1_8) and Zoonotic disease Factor (FAC1_9). As expected, the sixth variable that showed up in this model is the poultry variable being one of the major livestock predominantly kept by households in the study area.

The estimated coefficients for variables FAC1_8, FAC1_9 and FAC2_1 were all highly statistically significant at the 1% level of confidence. These three factors were positive with the exception of FAC1_8 which showed a negative influence on the dependent variable (WTP). Only two estimated coefficients, Poultry and FAC1_5, were statistically significant at the 5 percent level of confidence. The poultry coefficient has a positive influence on the WTP for health risk reduction associated with livestock keeping in the study location. The results also show that FAC1_2 (Environmental factor) has a positive effect on WTP for health risk reduction associated with keeping livestock. The interpretation of this is that people that keep livestock, especially poultry birds, are more likely to pay for health risk reduction associated with such activity. If they perceived the risk involved affects the environment and could cause transfer of animal diseases to human with catastrophic potential. If the people involved in such activities have no experience in dealing with such risks. Finally, if there is economic/or social benefits derived from keeping the livestock.

6.5.3 Estimated Results and Effects on Overall Perceived Risks Associated with Livestock Keeping

Table 6-5 shows the results of the logistic regression model that examined the overall riskiness of some specific activities associated with livestock keeping as perceived by respondents. In all the four sub-models, six distinct factors consistently show up to be statistically significant predictors for the dependent variable (Overall Perceived Riskiness). The Model on which discussion is based (Model 3-4) was selected on the basis of its high R-squared value (0.1735) and the highly significant chi-square statistic.

The goodness-of-fit of estimation is further evident in the model's ability to predict the respondent's actual choice correctly 70.1 percent of the time.

Six estimated coefficients have statistically significant influence on the probability of an individual to perceive the overall riskiness of activities associated with livestock keeping being extremely risky. The statistically significant factors are Severity Factor (FAC1_1), Pollution control Factor (FAC1_2), Knowledge Factor (FAC1_4), Awareness Factor (FAC1_6), Economic/Social Benefits Factor (FAC2_1), and Cultural/Nutritional Factor (FAC2_2). The coefficients for FAC1_1, FAC1-6 and FAC2_2 showed significance at the 1% level of confidence. All these factors were positive with the exception of FAC2_2 which has a negative sign on the coefficient. The other coefficients, FAC 1_2 and FAC2_1, are statistically significant at the 5 percent level with FAC1_ 2 having a negative effect on overall riskiness while FAC2_1 has a positive effect on the probability of overall riskiness. The only coefficient that was significant at the 10% level of confidence is the FAC1_4 (Knowledge Factor). It also has a positive effect on the probability of overall riskiness.

Unexpectedly, most of the socioeconomic variables included in the model are not statistically significant. For example, age, gender, presence of children under the age of 18 in the household, educational status, and type of livestock kept do not have significant impact on the probability of overall perceived riskiness of livestock keeping activity to be extremely risky. This implies that the overall perceived riskiness of some activities associated with keeping livestock cuts across age group, gender, family composition, household location and household size.

6.6 Chapter Summary

Estimation results for our three proposed models to address household members' decision making process were reported and discussed in this chapter. From the logistic regression analysis in determining factors that influence households' decisions to keep livestock and their willingness-to-pay for a reduction in health risk, it was found that a reasonable number of factors do actually influence households in making such decisions.

Specifically, the first model specifies the factors that influence households' decision to keep livestock. It includes three statistically significant socioeconomic variables (household location, number of children under 18 years and household size). The second logit regression model used to predict the probability of the WTP for health risks reduction associated with livestock keeping showed that five risks attributes and one combination of perceived benefits derived from keeping livestock either directly or indirectly affect such a decision. The third logistic regression model identified six statistically significant risk attributes to estimate factors affecting the overall perceived riskiness of livestock keeping activities as perceived by individual households to be extremely risky or not.

Based on the results obtained and discussed in this chapter and in the previous ones, conclusions are drawn and recommendations are made in the next chapter. An overview of the study findings and implications are given. A general summary of the whole study and limitations to the study are also outlined in the next chapter.

7.0 CHAPTER SEVEN: SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

7.1 Introduction

In this chapter is a summary of the major findings of the study and brief discussion of how each objective was achieved to solve the problem. Relevant conclusions are derived from the results obtained and compared with other studies to gain further insights into study implications of such findings. Limitations of the study are highlighted and possible areas for further research recommended.

7.2 Summary and Conclusions of the Study

The purpose of this study was to determine and predict the probabilities of decisions made by households and how they perceived risks associated with urban livestock keeping. The data utilized in this study was collected through household-level survey interviews using self-administered questionnaire. Potential respondents were purposively selected based on the metropolitan location of their households and whether they keep livestock or not. The primary objective of the study was to assess and characterize potential health risks associated with livestock keeping in urban and peri-urban locations. Specifically, the study aimed in determining what socioeconomic factor influences households' choice behaviour for keeping livestock and how they perceived the potential health risks associated with such livelihood activity.

In order to address these objectives, logistic regression analyses were conducted for the following outcomes: potential influence of some socio-demographic factors on the decision to keep livestock or not; household overall attitudes and perception of health risks associated with livestock keeping and finally household willingness to pay for potential health risk reduction associated with livestock keeping. A series of independent variables was entered into the logistic regression models and insignificant ones eliminated through an iterative process. Individual characteristics (age, gender, education, marital status); household characteristics (household size, presence of children in the household, ownership of dwelling place, years lived in the community, types of livestock kept, household income group); and perceived health risk attributes are some of the variables used in these analyses. Factor analysis was applied to the psychometric scales used in assessing household's perceived risk attributes.

The descriptive statistics indicate that poultry keeping occur in all household locations but are predominant in peri-urban and urban households. The densely populated urban households tend to keep more poultry that require relatively smaller housing units or unit area per livestock. The choice and type of livestock kept by the household is also an indication of the relatively high metropolitan population density in the study location. The sample mean age category was approximately 34.5years and more than half (57%) of the respondents that keep livestock are married. A significant proportion of respondents that keep livestock also indicated attainment of a secondary education or higher as their highest educational status.

The logistic regression (*model 1-4)* for *socio-demographic determinants of household decision to keep livestock* (Table 6-3) seems to be the most statistically and economically satisfactory model. Given the variables which emerged as statistically significant in this model, respondents that are more likely to keep livestock in their households were (1) those with at least four-member household size or more, (2) those living in households located within peri-urban purview and with some characteristics of urban linkages, and (3) those with children 18 years and older living in the households. The model correctly classified approximately 82% of respondents in this choice category.

When estimating respondents' *willingness-to-pay for potential health risk reductions associated with livestock keeping* in model 2-1, the primary determinants are if respondent perceived the risk involved in such activity affects the environment, if the risks are known to scientists (knowledge), if people involved in such activities have no experience in dealing with identified health risks, and finally if respondents derive economic/social benefits from such activity. Another variable that showed up in this second model is the FAC1_9 (human-animal interaction with sick animals causing zoonotic disease); the coefficient of this factor positively influenced the WTP for health risk reduction associated with livestock keeping (Table 6-4). Another interesting variable affecting this decision is those individuals keeping poultry have negative WTP. This model proves to be the most satisfactory model in explaining this variable. With a rho-squared of only 0.10, however, it correctly classified approximately 66% of respondents making this decision.

Finally, the logistic regression model (3-4) *predicting the determinants of households' overall perceived riskiness and attitudes toward livestock keeping* (Table 6-5) proved satisfactory in explaining our result. Herein, 'overall perceived riskiness' is defined as the average scores of all identified potential human and environmental health risks associated with livestock keeping in the study location. Those respondents more likely to assess the 'overall perceived riskiness' of keeping livestock to be extremely "risky" were (1) those that believe that the severity level of the consequence of close contact of humans with sick animals could be fatal; (2) those that believe they have no control of environmental pollution from animal wastes/odour; (3) those that believe they have significant experience and knowledge in handling health risk concerns associated with livestock; (4) those that are aware of health risks involved in keeping livestock close to humans; (5) those that believe they benefit economically and socially by keeping livestock; and (6) those that believe cultural and nutritional factors such as food habits, religious beliefs and changes in farming practices could negatively influence them to consider such activity to be extremely risky.

In regards to *familiarity with associated health concerns linked to livestock keeping*, there is not much difference by gender in the relative percentage of respondents (over 70%) that indicated their knowledge with some of these identified health risks while 16 percent male and 11 percent female indicated they are unfamiliar. Overall, it seems there is general risk attitude awareness to some of the health concerns associated with livestock keeping across gender.

With regards to *different benefits derived from livestock keeping as perceived by various households*, all households viewed additional cash income, household food security and subsistence means as contributing high potential benefits to their household welfare. One key finding obtained from this study is that respondents placed more value on economic benefits derived from behavioural activities such as livestock keeping than on health risks associated with such activities. This shows that the behaviour of these households keeping livestock does not differ from that of a rational consumer.

7.3 Health and Public Policy Implications of Findings

The findings reported in this study have obvious implications for urban development and management of human and animal health that could be of interest to urban policy makers. The outcome of the study tends to establish some public policy responses around urban and peri-urban livestock keeping and public awareness of "emerging" zoonoses that could affect the livelihood of urban agriculture practitioners. Given the limitations of this analysis, the following issues appear to be pertinent with regard to lessons and implications stemming from the findings of this study, as discussed in the section above.

The implication of the descriptive statistics given about the predominant livestock keeping system adopted in the study location and the type of livestock kept is an indication of the population parameters. Poultry birds are linked to all households in the study area especially in urban and peri-urban household locations and are usually associated with major disease outbreaks that have led to epidemic situations.

Kaduna State happens to be the third most populated State in Nigeria after Kano and Lagos States, with a population of over 6 million people (see Table 5-1). The metropolitan population density is about 700 people per square kilometre (http://www.kadunastate-ng.com/kad.html) compared to the province of Alberta which is about 5 people per square kilometre. Underemployment of this teeming population could be another reason for engaging in urban and peri-urban livestock keeping. The study implication is that for an average respondent who lives in a household located in the peri-urban area with more matured kids living in the household and with household size greater than four members is more likely to keep livestock.

The result show that livestock keeping decisions made by households, being traditionally an activity associated with rural settings, has transited from these boundaries to peri-urban and urban areas as a result of the perceived economic benefits associated with it.

Further, in our study, respondents evaluation of the potential consequences associated with the risk of keeping livestock are perceived by respondents to be a voluntary activity and they have little or no control over such consequences. Such activities are also linked to numerous animal diseases which can pass to humans and affect health. This activity was evaluated positively and assessed to be extremely "risky". Respondents reported their familiarity with some of these associated health risks but the economic benefits of "urban" livestock keeping override these perceived health risks. Results of our study suggest that there is still more research work to be conducted in the areas of animal-to-human and animal-to-animal disease interaction in order to ensure the sustainability of livestock development in Nigeria. Livestock policy formulation should be informed by economic analysis that is based on demographic characteristics of the population and its economic and socioeconomic values as well as cultural inclinations.

7.4 Possible Limitations and Future Research Initiatives

This study uses a survey questionnaire to collect data from respondents which usually comes with inherent limitations in terms of the method used in collecting the data and the design of the survey. Some of the major limitations are discussed below.

An application of contingent valuation approach in eliciting respondents' preference for their hypothetical willingness-to-pay for health risk reduction was also used in this study. A potential limitation of this approach is our inability to get a spontaneous maximum WTP from sampled households, which could lead to hypothetical bias. Information on the actual amount respondents are willing to pay to keep livestock in their households was not readily available. The survey results were collected at a time of avian flu outbreak heightening responses to concerns about animal diseases. Given the limitation of this study, there are still more data to exploit from the survey that could shed more light on how people view risks and benefits associated with keeping animals in their households. As well, further research could be used to identify and estimate objective measures of risks (such as water and air quality) rather than dealing with only perception of risks.

The discretion of the researcher in using dummy variables for some socio-demographic variables may have some limitations on our study and the interpretation of this study outcome should be taken with caution. It is therefore suggested that in further work, the measurement and coding of actual number of years of education attained, years lived in the household, and the actual household size are probable areas for further research.

Furthermore, information on the actual income level of households was difficult to elicit from respondents to include in the logit model in estimating the probability of WTP for health risk reductions. People sometimes are suspicious when asked about their income amount during a survey interview. So what we did in this study is to find an income proxy as an instrumental variable (IV) for the income category of each household surveyed in our current study.

Another limitation of this research is that data was obtained from different metropolitan areas as the unit of analysis; a number of variables was desirable to have in the model but could not be collected because of resource limitations. Both the data used and the unit of analysis is generally constrained by what data can be obtained from available sources with little additional effort. For instance, a good measure of benefits derived from keeping livestock to the participating households could have been equaled to the average amount of money spent on such activity by an individual participant. Alternatively, it could be estimated as the average contribution livestock keeping makes to a participant's household income. This poses a limitation to this study since data were not available. The benefits quantified in this study rely heavily on respondents' perceived judgment of what they defined as benefit as a result of their decision to keep livestock.

Despite the highlighted limitations, the key findings of this study show that respondents reported their familiarity with some of these associated health risks but the economic benefits of "urban" livestock keeping outweigh these perceived health risks. The general results of this study point to the importance of livestock keeping as a livelihood strategy for poor households in developing countries. It also highlighted the importance of livestock in the global effort to alleviate poverty and promoting policy that will enhance human health. Concerted research efforts should be directed at creating more public awareness to address the beneficial linkages between urban livestock development and poverty alleviation, as well as the control and prevention of emerging zoonotic diseases that have potentially serious human health and economic impacts.

In concluding this study effort put forth in our WTP method, a "harm reduction" approach was adopted. From a public policy perspective, the outcome of the result shows that a zero risk reduction would be an impossible task to enforce in developing countries. Therefore, policy makers in these countries should be cautious in assigning an appropriate risk level in poor countries compared to that acceptable in rich countries.

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APPENDICES

A1: Appendix to Chapter Five

A1-1: Total Variance Explained of Retained Items, Rotated Factor Loadings and Eigenvalues for Nine Perceived Risk Attribute Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.620	17.111	17.111	4.620	17.111	17.111
2	2.838	10.511	27.623	2.838	10.511	27.623
3	2.155	7.981	35.604	2.155	7.981	35.604
4	1.788	6.622	42.226	1.788	6.622	42.226
5	1.537	5.691	47.917	1.537	5.691	47.917
6	1.342	4.970	52.887	1.342	4.970	52.887
7	1.276	4.727	57.615	1.276	4.727	57.615
8	1.245	4.611	62.225	1.245	4.611	62.225
9	1.083	4.012	66.237	1.083	4.012	66.237

Extraction Method: Principal Component Analysis.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.794	.792	27

Bartlett and KMO Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.668
Bartlett's Test of Sphericity	Approx. Chi-Square	1240.673
	df	351
	Sig.	.000

A1-2: Total Variance Explained of Retained Items, Rotated Factor Loadings and Eigenvalues for Perceived Livestock Benefit Factors

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings			
	Total	% of Variance	Cumulative %	Total	Total	% of Variance	Cumulative %
1	2.725	38.926	38.926	2.725	2.297	32.816	32.816
2	1.337	19.101	58.027	1.337	1.765	25.210	58.027
3	.890	12.712	70.739				
4	.641	9.151	79.889				
5	.547	7.810	87.699				
6	.508	7.264	94.963				
7	.353	5.037	100.000				

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.725	.729	7

Bartlett and KMO Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.704
Bartlett's Test of Sphericity	Approx. Chi-Square	265.593
	df	21
	Sig.	.000

A1-3: Total Variance Explained of Retained Items, Rotated Factor Loadings and Eigenvalues for Perceived Livestock Importance Factors

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings			
	Total	% of Variance	Cumulative %	Total	Total	% of Variance	Cumulative %
1	2.482	49.645	49.645	2.482	2.144	42.884	42.884
2	1.267	25.333	74.978	1.267	1.605	32.095	74.978
3	.591	11.830	86.808				
4	.432	8.641	95.449				
5	.228	4.551	100.000				

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.736	.741	5

Bartlett and KMO Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.642
Bartlett's Test of Sphericity	Approx. Chi-Square	332.186
	df	10
	Sig.	.000

A2: Appendix to Chapter Six

MODEL 1-1: Socio-Demographic Determinants of Households' Decision to Keep Livestock

```
VARIABLE    ESTIMATED       STANDARD      T-RATIO    ELASTICITY       AGGREGATE
 NAME      COEFFICIENT       ERROR                    AT MEANS        ELASTICITY

 MALE       0.24831      0.33766       0.73537     0.23262E-01  0.23111E-01
 AVGAGE2    0.42110E-03  0.43215E-03   0.97443     0.73292E-01  0.66625E-01
 NHLOC2     0.73799      0.33602       2.1962      0.54217E-01  0.44137E-01
 NMARST     0.32232      0.44464       0.72489     0.27176E-01  0.22345E-01
 HHSIZE    -1.2790       0.36885      -3.4674     -0.44773E-01 -0.78206E-01
 EDUST      0.14612      0.38101       0.38350     0.71325E-02  0.64554E-02
 YRLV      -1.4872       0.98631      -1.5079     -0.43998E-02 -0.66515E-02
 NOFCHD    -0.79281      0.41206      -1.9240     -0.19154E-01 -0.33368E-01
 CONSTANT   0.95914      0.51892       1.8484      0.14282      0.14758

 SCALE FACTOR =   0.12673

 VARIABLE        MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME           EFFECT     CASE          X=0          X=1          MARGINAL
                             VALUES                                   EFFECT
 MALE          0.31468E-01   1.0000       0.85491      0.88308       0.28172E-01
 AVGAGE2       0.53367E-04   1168.8
 NHLOC2        0.93527E-01   0.0000       0.88308      0.94047       0.57389E-01
 NMARST        0.40848E-01   1.0000       0.84549      0.88308       0.37595E-01
 HHSIZE       -0.16209       0.0000       0.88308      0.67765      -0.20543
 EDUST         0.18518E-01   0.0000       0.88308      0.89735       0.14262E-01
 YRLV         -0.18848       0.0000       0.88308      0.63059      -0.25250
 NOFCHD       -0.10047       0.0000       0.88308      0.77367      -0.10941

 LOG-LIKELIHOOD FUNCTION = -121.81
 LOG-LIKELIHOOD(0)  =   -146.29
 LIKELIHOOD RATIO TEST =   48.9536    WITH     8 D.F.   P-VALUE= 0.00000

 ESTRELLA R-SQUARE            0.16255
 MADDALA R-SQUARE             0.14964
 CRAGG-UHLER R-SQUARE         0.24118
 MCFADDEN R-SQUARE            0.16732
 ADJUSTED FOR DEGREES OF FREEDOM         0.14459
 APPROXIMATELY F-DISTRIBUTED  0.22606     WITH 8    AND 9 D.F.
 CHOW R-SQUARE                0.16160

 NUMBER OF RIGHT PREDICTIONS =        246.
 PERCENTAGE OF RIGHT PREDICTIONS =    0.81457
 NAIVE MODEL PERCENTAGE OF RIGHT PREDICTIONS =    0.81126
```

MODEL 1-2: Socio-Demographic Determinants of Households' Decision to Keep Livestock

```
VARIABLE   ESTIMATED      STANDARD     T-RATIO   ELASTICITY    AGGREGATE
NAME       COEFFICIENT    ERROR                   AT MEANS     ELASTICITY

MALE        0.21924       0.33877      0.64715   0.32748E-01  0.33527E-01
AVGAGE      0.37766E-01   0.21583E-01  1.7498     0.56412E-02  0.57755E-02
YRLV       -1.5591        1.0612      -1.4692    -0.23289     -0.23844
NHLOC2      0.75654       0.33742      2.2421     0.11301      0.11570
NOFCHD     -0.87161       0.40510     -2.1516    -0.13020     -0.13329
HHSIZE     -1.3728        0.36942     -3.7162    -0.20507     -0.20995
INCCAT     -0.53397       0.41683     -1.2810    -0.79761E-01 -0.81659E-01
CONSTANT    0.89260       0.83507      1.0689     0.13333      0.13650

 SCALE FACTOR =   0.12706

  MARGINAL EFFECTS ASSUME ALL VARIABLES ARE LOG-TRANSFORMED
  (EXCEPT DUMMY VARIABLES)

 VARIABLE      MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME         EFFECT        CASE        X=0          X=1         MARGINAL
                              VALUES                                EFFECT
 MALE        0.27856E-01   1.0000      0.83370      0.86192     0.28218E-01
 AVGAGE      0.80808E-21   33.190
 YRLV       -0.19811       0.0000      0.86192      0.56763    -0.29429
 NHLOC2      0.96127E-01   0.0000      0.86192      0.93008     0.68157E-01
 NOFCHD     -0.11075       0.0000      0.86192      0.72307    -0.13885
 HHSIZE     -0.17444       0.0000      0.86192      0.61265    -0.24927
 INCCAT     -0.67846E-01   1.0000      0.91414      0.86192    -0.52222E-01

 LOG-LIKELIHOOD FUNCTION = -121.34
 LOG-LIKELIHOOD(0)   =   -146.29
 LIKELIHOOD RATIO TEST =    49.8941    WITH     7 D.F.   P-VALUE= 0.00000

 ESTRELLA R-SQUARE            0.16568
 MADDALA R-SQUARE             0.15229
 CRAGG-UHLER R-SQUARE         0.24544
 MCFADDEN R-SQUARE            0.17054
 ADJUSTED FOR DEGREES OF FREEDOM          0.15079
 APPROXIMATELY F-DISTRIBUTED    0.23497   WITH 7  AND     8 D.F.
 CHOW R-SQUARE                0.17122

 NUMBER OF RIGHT PREDICTIONS =          248.
 PERCENTAGE OF RIGHT PREDICTIONS =    0.82119
 NAIVE MODEL PERCENTAGE OF RIGHT PREDICTIONS =    0.81126
```

MODEL 1-3: Socio-Demographic Determinants of Households' Decision to Keep Livestock

```
VARIABLE   ESTIMATED      STANDARD     T-RATIO    ELASTICITY      AGGREGATE
NAME     COEFFICIENT       ERROR                  AT MEANS      ELASTICITY

MALE       0.15552      0.33333       0.46655     0.14675E-01  0.14857E-01
AVGAGE2    0.75801E-03  0.32017E-03   2.3675      0.13289      0.12097
YRLV      -1.6079       1.0412       -1.5443     -0.47913E-02 -0.64270E-02
NHLOC2     0.75139      0.33322       2.2549      0.55602E-01  0.45654E-01
HHSIZE    -1.6485       0.34324      -4.8029     -0.58129E-01 -0.10410
INCCAT    -0.58270      0.41472      -1.4051     -0.69165E-01 -0.72837E-01
CONSTANT   1.2608       0.58017       2.1732      0.18910      0.19764

 SCALE FACTOR =   0.12749

 VARIABLE     MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME         EFFECT       CASE         X=0          X=1          MARGINAL
                             VALUES                                  EFFECT
 MALE       0.19827E-01   1.0000      0.82694      0.84808      0.21138E-01
 AVGAGE2    0.96638E-04   1168.8
 YRLV      -0.20499       0.0000      0.84808      0.52790     -0.32018
 NHLOC2     0.95794E-01   0.0000      0.84808      0.92208      0.74003E-01
 HHSIZE    -0.21017       0.0000      0.84808      0.51777     -0.33031
 INCCAT    -0.74288E-01   1.0000      0.90907      0.84808     -0.60989E-01

 LOG-LIKELIHOOD FUNCTION = -123.46
 LOG-LIKELIHOOD(0)  =   -146.29
 LIKELIHOOD RATIO TEST =  45.6511     WITH    6 D.F.   P-VALUE= 0.00000

 ESTRELLA R-SQUARE           0.15155
 MADDALA R-SQUARE            0.14029
 CRAGG-UHLER R-SQUARE        0.22611
 MCFADDEN R-SQUARE           0.15603
 ADJUSTED FOR DEGREES OF FREEDOM         0.13887
 APPROXIMATELY F-DISTRIBUTED    0.21569      WITH 6  AND     7 D.F.
 CHOW R-SQUARE               0.16305
 NUMBER OF RIGHT PREDICTIONS =        250.
 PERCENTAGE OF RIGHT PREDICTIONS =    0.82781
 NAIVE MODEL PERCENTAGE OF RIGHT PREDICTIONS =    0.81126
```

MODEL 1-4: Socio-Demographic Determinants of Households' Decision to Keep Livestock

```
VARIABLE   ESTIMATED      STANDARD        T-RATIO     ELASTICITY      AGGREGATE
 NAME     COEFFICIENT      ERROR                       AT MEANS       ELASTICITY

MALE      0.23074       0.34008         0.67848     0.34206E-01  0.35154E-01
AVGAGE    0.24863E-01   0.28855E-01     0.86164     0.36859E-02  0.37880E-02
NMARST    0.35588       0.45750         0.77789     0.52758E-01  0.54220E-01
YRLV     -1.5394        1.0324         -1.4910     -0.22821     -0.23453
NHLOC2    0.76665       0.33835         2.2659      0.11365      0.11680
NOFCHD   -0.76453       0.41754        -1.8310     -0.11334     -0.11648
INCCAT   -0.56481       0.42054        -1.3431     -0.83731E-01 -0.86052E-01
EDUST     0.19494       0.38480         0.50661     0.28900E-01  0.29701E-01
HHSIZE   -1.3833        0.37941        -3.6459     -0.20507     -0.21075
CONSTANT  1.0612        0.95430         1.1120      0.15732      0.16168

 SCALE FACTOR =   0.12627

  MARGINAL EFFECTS ASSUME ALL VARIABLES ARE LOG-TRANSFORMED
  (EXCEPT DUMMY VARIABLES)

 VARIABLE      MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME         EFFECT         CASE        X=0          X=1         MARGINAL
                              VALUES                                 EFFECT
 MALE        0.29135E-01   1.0000      0.84257      0.87082      0.28248E-01
 AVGAGE      0.52868E-21   33.190
 NMARST      0.44937E-01   1.0000      0.82525      0.87082      0.45568E-01
 YRLV       -0.19438       0.0000      0.87082      0.59118     -0.27964
 NHLOC2      0.96805E-01   0.0000      0.87082      0.93553      0.64709E-01
 NOFCHD     -0.96538E-01   0.0000      0.87082      0.75835     -0.11246
 INCCAT     -0.71318E-01   1.0000      0.92223      0.87082     -0.51410E-01
 EDUST       0.24615E-01   0.0000      0.87082      0.89121      0.20391E-01
 HHSIZE     -0.17467       0.0000      0.87082      0.62830     -0.24252

 LOG-LIKELIHOOD FUNCTION = -120.89
 LOG-LIKELIHOOD(0)   =   -146.29
 LIKELIHOOD RATIO TEST =    50.7950    WITH    9  D.F.   P-VALUE= 0.00000

 ESTRELLA R-SQUARE              0.16868
 MADDALA R-SQUARE               0.15481
 CRAGG-UHLER R-SQUARE           0.24951
 MCFADDEN R-SQUARE              0.17361
 ADJUSTED FOR DEGREES OF FREEDOM          0.14814
 APPROXIMATELY F-DISTRIBUTED    0.23343   WITH   9  AND    10  D.F.
 CHOW R-SQUARE                  0.17309
 NUMBER OF RIGHT PREDICTIONS =         247.
 PERCENTAGE OF RIGHT PREDICTIONS =    0.81788
 NAIVE MODEL PERCENTAGE OF RIGHT PREDICTIONS =    0.81126
```

MODEL 2-1: Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping

```
VARIABLE    ESTIMATED      STANDARD      T-RATIO     ELASTICITY     AGGREGATE
 NAME      COEFFICIENT      ERROR                    AT MEANS       ELASTICITY

 AGESQRD    0.50528E-02  0.90295E-02  0.55958        0.13649        0.12131
 MARST2    -0.38645      0.33675      -1.1476      -0.65117E-01 -0.59229E-01
 HHLOC2    -0.44902      0.29941      -1.4996      -0.60911E-01 -0.56352E-01
 POULTRY    0.72662      0.32015       2.2696       0.73668E-01  0.60986E-01
 PIGS      -0.24437      0.62493     -0.39103      -0.48852E-02 -0.43203E-02
 EDUSTAT    0.10111      0.22293      0.45354       0.73919E-01  0.65773E-01
 FAC1_1     0.17812      0.16564       1.0753       0.23365E-03 -0.19508E-03
 FAC1_2     0.32272      0.16771       1.9243       0.47862E-03 -0.10989E-02
 FAC1_3     0.85855E-01  0.17288      0.49662      -0.22787E-03 -0.29030E-03
 FAC1_4    -0.25435      0.17248      -1.4747      -0.20632E-03 -0.27580E-02
 FAC1_5    -0.28618      0.17102      -1.6734      -0.48491E-04 -0.11498E-02
 FAC1_6    -0.76852E-01  0.16791     -0.45769      -0.57747E-04  0.69709E-05
 FAC1_7    -0.26909E-01  0.16748     -0.16067       0.12719E-03  0.29275E-03
 FAC1_8    -0.48051      0.18217      -2.6378      -0.13861E-02 -0.50787E-02
 FAC1_9     0.45761      0.16853       2.7153       0.16582E-02 -0.41588E-02
 INCSMOTH  -0.21172      0.18691      -1.1327      -0.65661E-03 -0.94829E-03
 CONSMOTH   0.14515      0.17462      0.83120       0.49371E-03  0.20192E-03
 ECOSOCBN   0.55776      0.21291       2.6197       0.92770E-03 -0.36554E-02
 CULEVMB   -0.89737E-01  0.18550     -0.48375      -0.36073E-03 -0.49309E-03
 NBRCHD    -0.18967E-01  0.19686     -0.96350E-01 -0.17605E-01 -0.15677E-01
 CONSTANT   0.78137E-02  0.90914      0.85946E-02  0.32580E-02  0.29095E-02

 SCALE FACTOR =   0.24310

 VARIABLE     MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
  NAME         EFFECT        CASE          X=0          X=1          MARGINAL
                            VALUES                                    EFFECT
 AGESQRD     0.12284E-02   64.784
 MARST2     -0.93948E-01   0.0000       0.61599      0.52151      -0.94476E-01
 HHLOC2     -0.10916       0.0000       0.61599      0.50588      -0.11010
 POULTRY     0.17664       0.0000       0.61599      0.76838       0.15239
 PIGS       -0.59407E-01   0.0000       0.61599      0.55680      -0.59188E-01
 EDUSTAT     0.24579E-01   1.7534
 FAC1_1      0.43301E-01  0.31461E-02
 FAC1_2      0.78454E-01  0.35569E-02
 FAC1_3      0.20872E-01 -0.63653E-02
 FAC1_4     -0.61834E-01  0.19454E-02
 FAC1_5     -0.69573E-01  0.40637E-03
 FAC1_6     -0.18683E-01  0.18021E-02
 FAC1_7     -0.65418E-02 -0.11336E-01
 FAC1_8     -0.11681      0.69184E-02
 FAC1_9      0.11125      0.86903E-02
 INCSMOTH   -0.51470E-01  0.74378E-02
 CONSMOTH    0.35286E-01  0.81577E-02
 ECOSOCBN    0.13559      0.39890E-02
 CULEVMB    -0.21815E-01  0.96408E-02
 NBRCHD     -0.46110E-02   2.2260

 LOG-LIKELIHOOD FUNCTION = -179.14
 LOG-LIKELIHOOD(0)   = -199.37
 LIKELIHOOD RATIO TEST = 40.4534    WITH   20 D.F.   P-VALUE= 0.00438

 ESTRELLA R-SQUARE            0.13591
 MADDALA R-SQUARE             0.12937
 CRAGG-UHLER R-SQUARE         0.17371
 MCFADDEN R-SQUARE            0.10145
 ADJUSTED FOR DEGREES OF FREEDOM          0.35141E-01
 APPROXIMATELY F-DISTRIBUTED    0.11855    WITH    20 AND    21 D.F.
 CHOW R-SQUARE                0.13371
```

MODEL 2-2: Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping

```
VARIABLE   ESTIMATED      STANDARD    T-RATIO     ELASTICITY     AGGREGATE
NAME      COEFFICIENT      ERROR                   AT MEANS      ELASTICITY

AVGAGE     0.22918E-01  0.21084E-01   1.0870       0.32595       0.29698
AVPERBEN   0.41497      0.11718       3.5413       0.38990       0.35300
OVERISKI  -0.24541E-01  0.42501E-01  -0.57741     -0.41214E-01  -0.38008E-01
ACCTBID    0.64178E-03  0.23859E-02   0.26899      0.10400E-01   0.93768E-02
ALLTYPES  -0.20192      0.83774      -0.24103     -0.20914E-02  -0.19094E-02
NOFCHD1    0.78803      0.76589       1.0289       0.55968E-01   0.49345E-01
NOFCHD2    0.32197      0.72397       0.44473      0.61932E-01   0.56924E-01
NOFCHD3    0.41596      0.72871       0.57082      0.62779E-01   0.58004E-01
OWNHOU1    0.63774E-01  0.25538       0.24972      0.13022E-01   0.12125E-01
MARST2    -0.48776E-01  0.35995      -0.13551     -0.83719E-02  -0.78040E-02
MALE       0.81366      0.26736       3.0433       0.22152       0.19836
CONSTANT  -2.2569       1.1416       -1.9771      -0.96511      -0.88440

 SCALE FACTOR =   0.24476

VARIABLE      MARGINAL     ----- PROBABILITIES FOR A TYPICAL CASE -----
NAME           EFFECT        CASE        X=0          X=1          MARGINAL
                             VALUES                                 EFFECT
 AVGAGE      0.56094E-02   33.260
 AVPERBEN    0.10157       2.1972
 OVERISKI   -0.60066E-02   3.9273
 ACCTBID     0.15708E-03   37.896
  ALLTYPES  -0.49423E-01   0.0000      0.53959      0.48919     -0.50396E-01
  NOFCHD1    0.19288       0.0000      0.53959      0.72045      0.18087
  NOFCHD2    0.78806E-01   0.0000      0.53959      0.61790      0.78314E-01
  NOFCHD3    0.10181       0.0000      0.53959      0.63984      0.10025
  OWNHOU1    0.15609E-01   0.0000      0.53959      0.55539      0.15798E-01
  MARST2    -0.11939E-01   0.0000      0.53959      0.52745     -0.12139E-01
  MALE       0.19915       1.0000      0.34187      0.53959      0.19772

 LOG-LIKELIHOOD FUNCTION = -183.66
 LOG-LIKELIHOOD(0)  = -197.68
 LIKELIHOOD RATIO TEST = 28.0352    WITH    11  D.F.   P-VALUE= 0.00320

 ESTRELLA R-SQUARE            0.95722E-01
 MADDALA R-SQUARE             0.92451E-01
 CRAGG-UHLER R-SQUARE         0.12403
 MCFADDEN R-SQUARE            0.70911E-01
 ADJUSTED FOR DEGREES OF FREEDOM         0.34015E-01
 APPROXIMATELY F-DISTRIBUTED    0.83261E-01   WITH 11   AND 12 D.F.
 CHOW R-SQUARE                0.92770E-01
```

MODEL 2-3: Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping

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VARIABLE   ESTIMATED      STANDARD      T-RATIO      ELASTICITY     AGGREGATE
NAME     COEFFICIENT      ERROR                      AT MEANS       ELASTICITY

AVPERBEN  -25.975         0.50132E+06  -0.51813E-04 -23.351         -21.849
RISKY     -0.16237        0.25371      -0.64001      -0.31617E-01  -0.29466E-01
LVSTYPES   0.26242        0.95844E-01   2.7380      0.22396         0.21086
HHLOC3     0.21848        0.26894       0.81238      0.46765E-01   0.42341E-01
AGESQRD    0.90610E-02    0.69018E-02   1.3129       0.24055        0.22148
POULTRY    0.89413        0.32470       2.7537       0.97546E-01   0.88784E-01
PIGS       0.17818E-01    0.59404       0.29995E-01  0.36909E-03   0.36657E-03
NOFCHD2   -0.21441        0.25514      -0.84034     -0.39083E-01  -0.36307E-01
OWNHOU1    0.49198E-01    0.26381       0.18649      0.95795E-02   0.90828E-02
AVIMPORT   26.296         0.50132E+06   0.52454E-04  23.677         22.120
MALE       0.87068        0.26386       3.2997       0.22605        0.20375
CONSTANT  -2.3208         0.67214      -3.4529      -0.94867       -0.87755

 SCALE FACTOR =   0.24168

 VARIABLE      MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME         EFFECT       CASE          X=0           X=1          MARGINAL
                             VALUES                                    EFFECT
 AVPERBEN    -6.2774         2.1993
 RISKY      -0.39242E-01     0.0000       0.66837       0.63145      -0.36919E-01
 LVSTYPES    0.63420E-01     2.0878
 HHLOC3      0.52801E-01     1.0000       0.61830       0.66837       0.50069E-01
 AGESQRD     0.21898E-02     64.946
 POULTRY     0.21609         0.0000       0.66837       0.83131       0.16294
 PIGS        0.43062E-02     0.0000       0.66837       0.67231       0.39375E-02
 NOFCHD2    -0.51817E-01     0.0000       0.66837       0.61926      -0.49108E-01
 OWNHOU1     0.11890E-01     0.0000       0.66837       0.67918       0.10813E-01
 AVIMPORT    6.3552         2.2027
 MALE        0.21042         1.0000       0.45764       0.66837       0.21073

 LOG-LIKELIHOOD FUNCTION =  -182.88
 LOG-LIKELIHOOD(0)   =   -202.46
 LIKELIHOOD RATIO TEST  =     39.1595     WITH     11  D.F.    P-VALUE= 0.00005

 ESTRELLA R-SQUARE              0.12989
 MADDALA R-SQUARE               0.12392
 CRAGG-UHLER R-SQUARE           0.16625
 MCFADDEN R-SQUARE              0.96709E-01
 ADJUSTED FOR DEGREES OF FREEDOM          0.61722E-01
 APPROXIMATELY F-DISTRIBUTED     0.11680       WITH       11 AND    12  D.F.
 CHOW R-SQUARE                  0.12703
```

MODEL 2-4: Determinants of Households WTP for Health Risk Reduction Associated with Livestock Keeping

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VARIABLE   ESTIMATED          STANDARD     T-RATIO      ELASTICITY     AGGREGATE
NAME       COEFFICIENT        ERROR                     AT MEANS       ELASTICITY

ECOSOCBN   -0.10106        0.18339      -0.55108       0.42272E-03  0.18927E-03
CULEVMB    -0.20385        0.16834      -1.2109        0.32908E-03 -0.89654E-03
INCSMOTH    0.13449        0.17356       0.77491       0.16488E-03  0.12271E-03
CONSMOTH    0.33547        0.16417       2.0434       -0.13540E-02 -0.82193E-03
 FAC1_1    -0.24190E-01    0.15565      -0.15541      -0.10184E-03 -0.16692E-03
 FAC1_2     0.14536        0.15709       0.92534      -0.76640E-04 -0.92859E-03
 FAC1_4     0.87617E-01    0.15699       0.55812      -0.18821E-03 -0.45006E-03
 FAC1_6     0.21848        0.15920       1.3723       -0.74476E-03 -0.15321E-02
 LVSTYPES   0.63266E-02    0.81259E-01   0.77858E-01   0.58255E-02  0.54883E-02
 HHLOC3    -0.47798        0.26729      -1.7882       -0.10249      -0.99563E-01
 HHSIZE2    0.50782E-01    0.27877       0.18216       0.56226E-02  0.52753E-02
 AVGAGE     0.87349E-02    0.15020E-01   0.58154       0.12271      0.11599
 OWNHOU1    0.34403        0.24776       1.3886        0.69431E-01  0.64255E-01
 MALE       0.63469        0.25180       2.5206        0.16901      0.15640
 CONSTANT  -0.32508        0.60359      -0.53858      -0.13759      -0.13039

 SCALE FACTOR =   0.24411

 VARIABLE     MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
 NAME         EFFECT          CASE          X=0           X=1          MARGINAL
                              VALUES                                   EFFECT
 ECOSOCBN    -0.24671E-01 -0.98820E-02
 CULEVMB     -0.49762E-01 -0.38140E-02
 INCSMOTH     0.32832E-01  0.28963E-02
 CONSMOTH     0.81892E-01 -0.95361E-02
 FAC1_1      -0.59049E-02  0.99471E-02
 FAC1_2       0.35485E-01 -0.12457E-02
 FAC1_4       0.21388E-01 -0.50752E-02
 FAC1_6       0.53332E-01 -0.80539E-02
 LVSTYPES     0.15444E-02   2.1755
 HHLOC3      -0.11668       1.0000      0.64786       0.53287      -0.11499
 HHSIZE2      0.12397E-01   0.0000      0.53287       0.54548       0.12617E-01
 AVGAGE       0.21323E-02   33.190
 OWNHOU1      0.83981E-01   0.0000      0.53287       0.61673       0.83862E-01
 MALE         0.15493       1.0000      0.37683       0.53287       0.15604

 LOG-LIKELIHOOD FUNCTION = -196.71
 LOG-LIKELIHOOD(0)  = -206.11
 LIKELIHOOD RATIO TEST =    18.8159   WITH  14  D.F.  P-VALUE= 0.17210

 ESTRELLA R-SQUARE           0.61780E-01
 MADDALA R-SQUARE            0.60403E-01
 CRAGG-UHLER R-SQUARE        0.81120E-01
 MCFADDEN R-SQUARE           0.45644E-01
 ADJUSTED FOR DEGREES OF FREEDOM          -0.90952E-03
 APPROXIMATELY F-DISTRIBUTED    0.51244E-01  WITH       14  AND    15  D.F.
 CHOW R-SQUARE               0.61059E-01
```

MODEL 3-1: Overall Perceived Riskiness of Livestock Keeping by Respondent's Household

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VARIABLE   ESTIMATED      STANDARD   T-RATIO     ELASTICITY    AGGREGATE
NAME      COEFFICIENT     ERROR                  AT MEANS      ELASTICITY

AGESQRD  -0.80215E-03  0.87864E-02 -0.91294E-01 -0.28458E-01 -0.22810E-01
 MARST2   -0.28568      0.34332     -0.83211     -0.63221E-01 -0.50755E-01
 HHLOC2   -0.13249E-01  0.31067     -0.42648E-01 -0.23606E-02 -0.18301E-02
 POULTRY   0.44712E-01  0.31577      0.14160      0.59536E-02  0.47135E-02
 EDUSTAT   0.10564      0.22823      0.46289      0.10144      0.81707E-01
 FAC1_1    0.69191      0.18592      3.7216       0.11921E-02 -0.42701E-02
 FAC1_2   -0.38874      0.18187     -2.1374      -0.75720E-03 -0.64896E-02
 FAC1_3    0.27445      0.18308      1.4991      -0.95667E-03  0.16894E-02
 FAC1_4    0.38596      0.17765      2.1726       0.41118E-03  0.26087E-02
 FAC1_5   -0.27766E-01  0.17701     -0.15686     -0.61789E-05 -0.40634E-03
 FAC1_6    0.60284      0.18136      3.3240       0.59491E-03  0.79862E-02
 FAC1_7    0.15177      0.17220      0.88133     -0.94214E-03 -0.10435E-02
 FAC1_8    0.29477      0.17746      1.6610       0.11168E-02  0.40895E-03
 FAC1_9   -0.52801E-02  0.17508     -0.30158E-01 -0.25128E-04  0.16512E-05
 INCSMOTH  0.16853      0.19871      0.84810      0.68643E-03  0.30762E-02
 CONSMOTH -0.14851      0.17401     -0.85342     -0.66343E-03  0.78419E-03
 ECOSOCBN  0.43851      0.21908      2.0016       0.95790E-03  0.82775E-02
 CULEVMB  -0.56213      0.20517     -2.7399      -0.29678E-02  0.13565E-01
 NBRCHD   -0.12439      0.19983     -0.62248     -0.15163     -0.12223
 CONSTANT  0.63931E-01  0.91145      0.70142E-01  0.35010E-01  0.28124E-01

 SCALE FACTOR =   0.24773

 VARIABLE    MARGINAL   ----- PROBABILITIES FOR A TYPICAL CASE -----
 NAME        EFFECT        CASE        X=0          X=1      MARGINAL
                          VALUES                              EFFECT
 AGESQRD  -0.19872E-03   64.784
 MARST2   -0.70773E-01   0.0000      0.47947      0.40906     -0.70409E-01
 HHLOC2   -0.32823E-02   0.0000      0.47947      0.47616     -0.33058E-02
 POULTRY   0.11077E-01   0.0000      0.47947      0.49064      0.11168E-01
 EDUSTAT   0.26171E-01   1.7534
 FAC1_1    0.17141      0.31461E-02
 FAC1_2   -0.96304E-01  0.35569E-02
 FAC1_3    0.67990E-01 -0.63653E-02
 FAC1_4    0.95614E-01  0.19454E-02
 FAC1_5   -0.68785E-02  0.40637E-03
 FAC1_6    0.14934      0.18021E-02
 FAC1_7    0.37598E-01 -0.11336E-01
 FAC1_8    0.73024E-01  0.69184E-02
 FAC1_9   -0.13081E-02  0.86903E-02
 INCSMOTH  0.41750E-01  0.74378E-02
 CONSMOTH -0.36790E-01  0.81577E-02
 ECOSOCBN  0.10863      0.39890E-02
 CULEVMB  -0.13926      0.96408E-02
 NBRCHD   -0.30815E-01   2.2260

 LOG-LIKELIHOOD FUNCTION = -172.14
 LOG-LIKELIHOOD(0)  =   -201.57
 LIKELIHOOD RATIO TEST =     58.8502    WITH    19 D.F.   P-VALUE= 0.00001

 ESTRELLA R-SQUARE            0.19576
 MADDALA R-SQUARE             0.18253
 CRAGG-UHLER R-SQUARE         0.24384
 MCFADDEN R-SQUARE            0.14598
       ADJUSTED FOR DEGREES OF FREEDOM         0.86324E-01
       APPROXIMATELY F-DISTRIBUTED    0.17993     WITH      19 AND   20  D.F.
 CHOW R-SQUARE                0.19178
```

MODEL 3-2: Overall Perceived Riskiness of Livestock Keeping by Respondent's Household

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VARIABLE     ESTIMATED       STANDARD     T-RATIO      ELASTICITY      AGGREGATE
 NAME        COEFFICIENT      ERROR                     AT MEANS       ELASTICITY

AVGAGE      0.11719E-01   0.22629E-01  0.51790       0.20901           0.17534
 MARST1     -0.98950E-01   0.37934      -0.26085      -0.30401E-01 -0.25600E-01
 MALE       -0.16288       0.26875      -0.60606      -0.54867E-01 -0.45099E-01
 HHLOC2      0.24839E-01   0.28281       0.87829E-01   0.43675E-02  0.36186E-02
 OWNHOU1     0.84826E-01   0.27305       0.31066       0.21666E-01  0.18323E-01
 NOFCHD1    -0.18092       0.37681      -0.48012      -0.15738E-01 -0.13648E-01
 INCCAT     -0.34474       0.33561      -1.0272      -0.14739       -0.12257
 EDUSTAT     0.12066       0.22222       0.54296       0.11412       0.96103E-01
 FAC1_1      0.65284       0.18190       3.5891        0.51404E-02  0.39534E-03
 FAC1_2     -0.36612       0.17209      -2.1274        0.71196E-03 -0.32133E-02
 FAC1_4      0.30009       0.17451       1.7196       -0.55486E-04  0.17915E-02
 FAC1_6      0.58101       0.17603       3.3006       -0.40994E-02  0.27150E-02
 ECOSOCBN    0.40022       0.19377       2.0655       -0.46686E-03  0.51020E-02
 CULEVMB    -0.44947       0.19048      -2.3598       -0.23895E-02  0.98632E-02
 CONSTANT   -0.33962       0.81929      -0.41453      -0.18292      -0.15344

 SCALE FACTOR =   0.24851

 VARIABLE       MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
  NAME           EFFECT          CASE          X=0           X=1           MARGINAL
                                VALUES                                      EFFECT
 AVGAGE      0.29124E-02    33.113
 MARST1     -0.24590E-01     1.0000        0.43796       0.41377      -0.24188E-01
 MALE       -0.40478E-01     1.0000        0.45376       0.41377      -0.39983E-01
 HHLOC2      0.61728E-02     0.0000        0.41377       0.41981       0.60378E-02
 OWNHOU1     0.21080E-01     0.0000        0.41377       0.43449       0.20715E-01
 NOFCHD1    -0.44960E-01     0.0000        0.41377       0.37068      -0.43094E-01
 INCCAT     -0.85670E-01     1.0000        0.49909       0.41377      -0.85313E-01
 EDUSTAT         0.29985E-01   1.7560
 FAC1_1          0.16224       0.14619E-01
 FAC1_2         -0.90984E-01 -0.36106E-02
 FAC1_4          0.74575E-01 -0.34330E-03
 FAC1_6          0.14439      -0.13100E-01
 ECOSOCBN        0.99459E-01 -0.21658E-02
 CULEVMB        -0.11170       0.98704E-02

 LOG-LIKELIHOOD FUNCTION =  -177.08
 LOG-LIKELIHOOD(0)   =   -201.09
 LIKELIHOOD RATIO TEST  =     48.0158    WITH    14  D.F.   P-VALUE= 0.00001

 ESTRELLA R-SQUARE           0.16114
 MADDALA R-SQUARE            0.15211
 CRAGG-UHLER R-SQUARE        0.20310
 MCFADDEN R-SQUARE           0.11939
      ADJUSTED FOR DEGREES OF FREEDOM          0.74723E-01
      APPROXIMATELY F-DISTRIBUTED    0.14526       WITH       14  AND    15  D.F.
 CHOW R-SQUARE               0.15191
```

MODEL 3-3: Overall Perceived Riskiness of Livestock Keeping by Respondent's Household

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VARIABLE      ESTIMATED     STANDARD  T-RATIO       ELASTICITY     AGGREGATE
NAME          COEFFICIENT    ERROR                   AT MEANS      ELASTICITY

 AVGAGE      0.13464E-01  0.22756E-01  0.59166        0.24047        0.20046
 MARSTI    -0.11286        0.38018      -0.29685      -0.34724E-01 -0.29038E-01
 MALE      -0.18770        0.27076      -0.69324      -0.63320E-01 -0.51701E-01
 HHLOC2     0.82114E-01  0.28993        0.28323       0.14459E-01  0.11809E-01
 OWNHOU1    0.87924E-01  0.27441        0.32041       0.22490E-01  0.18895E-01
 NOFCHD1   -0.17455        0.37782      -0.46200      -0.15206E-01 -0.13135E-01
 INCCAT    -0.32642        0.33841      -0.96456      -0.13976       -0.11595
 EDUSTAT    0.13400        0.22251        0.60219      0.12691        0.10615
 FAC1_1     0.64823        0.18254        3.5513       0.51115E-02  0.69605E-03
 FAC1_2    -0.40303        0.17578       -2.2928       0.78488E-03 -0.38743E-02
 FAC1_4     0.29678        0.17549        1.6912      -0.54955E-04  0.19630E-02
 FAC1_6     0.57377        0.17907        3.2041      -0.40542E-02  0.12924E-02
 INCSMOTH   0.20219        0.19306        1.0473       0.30222E-03  0.31843E-02
 CONSMOTH -0.10370         0.16956       -0.61155     -0.14724E-03  0.42501E-03
 ECOSOCBN   0.33830        0.20387        1.6594      -0.39520E-03  0.55071E-02
 CULEVMB  -0.44788         0.19507       -2.2960      -0.23845E-02  0.10677E-01
 CONSTANT -0.43682         0.82804       -0.52753     -0.23561       -0.19649

 SCALE FACTOR =   0.24845

 VARIABLE     MARGINAL       ----- PROBABILITIES FOR A TYPICAL CASE -----
 NAME          EFFECT         CASE          X=0           X=1          MARGINAL
                              VALUES                                     EFFECT
 AVGAGE      0.33450E-02   33.113
 MARSTI     -0.28039E-01   1.0000        0.43257       0.40511      -0.27463E-01
 MALE       -0.46635E-01   1.0000        0.45103       0.40511      -0.45919E-01
 HHLOC2      0.20401E-01   0.0000        0.40511       0.42504       0.19933E-01
 OWNHOU1     0.21845E-01   0.0000        0.40511       0.42646       0.21354E-01
 NOFCHD1    -0.43368E-01   0.0000        0.40511       0.36383      -0.41278E-01
 INCCAT     -0.81099E-01   1.0000        0.48555       0.40511      -0.80445E-01
 EDUSTAT     0.33291E-01   1.7560
 FAC1_1      0.16105        0.14619E-01
 FAC1_2     -0.10013       -0.36106E-02
 FAC1_4      0.73736E-01 -0.34330E-03
 FAC1_6      0.14255       -0.13100E-01
 INCSMOTH    0.50234E-01  0.27713E-02
 CONSMOTH  -0.25764E-01  0.26324E-02
 ECOSOCBN    0.84049E-01 -0.21658E-02
 CULEVMB    -0.11128       0.98704E-02

 LOG-LIKELIHOOD FUNCTION = -176.36
 LOG-LIKELIHOOD(0)   = -201.09
 LIKELIHOOD RATIO TEST =    49.4428     WITH     16 D.F.   P-VALUE= 0.00003

 ESTRELLA R-SQUARE            0.16581
 MADDALA R-SQUARE             0.15626
 CRAGG-UHLER R-SQUARE         0.20864
 MCFADDEN R-SQUARE            0.12294
      ADJUSTED FOR DEGREES OF FREEDOM        0.71725E-01
      APPROXIMATELY F-DISTRIBUTED    0.14893      WITH       16 AND    17 D.F.
 CHOW R-SQUARE                0.15557

PERCENTAGE OF RIGHT PREDICTIONS =    0.68041
```

MODEL 3-4: Overall Perceived Riskiness of keeping Livestock by Respondent's Household

```
VARIABLE    ESTIMATED       STANDARD      T-RATIO     ELASTICITY     AGGREGATE
  NAME     COEFFICIENT       ERROR                     AT MEANS      ELASTICITY

 AVGAGE        0.12740E-02  0.23292E-01  0.54697E-01  0.19908E-01  0.15782E-01
 MARST1       -0.25818E-01  0.39275     -0.65736E-01 -0.69499E-02 -0.55398E-02
 MALE         -0.77271E-01  0.28007     -0.27590     -0.23056E-01 -0.18468E-01
 HHLOC2       -0.33376      0.30622      -1.0900     -0.51418E-01 -0.40297E-01
 OWNHOU1      -0.21509      0.28715     -0.74907     -0.47786E-01 -0.37699E-01
 NOFCHD1      -0.16457      0.40100     -0.41040     -0.12543E-01 -0.10269E-01
 INCCAT       -0.22220      0.32933     -0.67472     -0.83237E-01 -0.65603E-01
 EDUSTAT       0.27224      0.23302       1.1683      0.22559      0.17947
 FAC1_1        0.97963      0.20642       4.7459      0.67583E-02 -0.11601E-01
 FAC1_2       -0.35452      0.19036      -1.8624      0.60405E-03 -0.67068E-02
 FAC1_4        0.28824      0.18336       1.5720     -0.46696E-04 -0.45742E-03
 FAC1_6        0.78201      0.19342       4.0431     -0.48343E-02 -0.56778E-02
 INCSMOTH      0.62463E-01  0.19949       0.31311     0.81685E-04  0.75561E-03
 CONSMOTH     -0.10842      0.17548     -0.61784     -0.13468E-03  0.39515E-03
 ECOSOCBN      0.47427      0.21252       2.2317     -0.48473E-03  0.47792E-02
 CULEVMB      -0.49165      0.20349      -2.4161     -0.22900E-02  0.86620E-02
 CONSTANT      0.69812E-01  0.79022       0.88346E-01  0.32944E-01  0.26209E-01

 SCALE FACTOR =   0.24921

 VARIABLE      MARGINAL      ----- PROBABILITIES FOR A TYPICAL CASE -----
   NAME         EFFECT        CASE         X=0          X=1         MARGINAL
                             VALUES                                  EFFECT
 AVGAGE        0.31750E-03   33.113
 MARST1       -0.64340E-02   1.0000       0.57196      0.56563     -0.63322E-02
 MALE         -0.19257E-01   1.0000       0.58451      0.56563     -0.18880E-01
 HHLOC2       -0.83177E-01   0.0000       0.56563      0.48257     -0.83053E-01
 OWNHOU1      -0.53604E-01   0.0000       0.56563      0.51223     -0.53395E-01
 NOFCHD1      -0.41013E-01   0.0000       0.56563      0.52484     -0.40783E-01
 INCCAT       -0.55375E-01   1.0000       0.61922      0.56563     -0.53592E-01
 EDUSTAT       0.67845E-01   1.7560
 FAC1_1        0.24413      0.14619E-01
 FAC1_2       -0.88351E-01 -0.36106E-02
 FAC1_4        0.71833E-01 -0.34330E-03
 FAC1_6        0.19488     -0.13100E-01
 INCSMOTH      0.15566E-01  0.27713E-02
 CONSMOTH     -0.27018E-01  0.26324E-02
 ECOSOCBN      0.11819     -0.21658E-02
 CULEVMB      -0.12252      0.98704E-02

 LOG-LIKELIHOOD FUNCTION =  -166.46
 LOG-LIKELIHOOD(0)   =   -201.42
 LIKELIHOOD RATIO TEST  =    69.9070    WITH    16  D.F.   P-VALUE= 0.00000

 ESTRELLA R-SQUARE             0.23191
 MADDALA R-SQUARE              0.21355
 CRAGG-UHLER R-SQUARE          0.28493
 MCFADDEN R-SQUARE             0.17354
      ADJUSTED FOR DEGREES OF FREEDOM         0.12528
      APPROXIMATELY F-DISTRIBUTED    0.22310     WITH      16  AND    17  D.F.
 CHOW R-SQUARE                 0.21789

 NUMBER OF RIGHT PREDICTIONS =         204.
 PERCENTAGE OF RIGHT PREDICTIONS =    0.70103
 NAIVE MODEL PERCENTAGE OF RIGHT PREDICTIONS =     0.52234
```

A3: Sample of Information Sheet for Participants

INFORMATION SHEET

Your household has been selected at random to help in a survey designed to get people's opinions regarding livestock keeping in their households and cities. The opinions of people like you are important because we are trying to understand household members' opinion about these issues. This interview will last for about 1 hour and you have the right to willingly participate or not to. There is no right or wrong answer but we will appreciate it if your responses could be as honest as possible as your input will help a great deal in achieving the purpose of the study. At no time will your name be attached to any specific comment you gave. The survey questions will focus mainly on socio-economic and demographic information and some attitudinal questions.

Thank you and your participation in the study is greatly appreciated!!!!

Project Title:

"Characterization and Assessment of Human and Environmental Health Risks associated with Urban and Peri-urban livestock keeping in Kaduna metropolis of Nigeria"

Purpose:

The purpose of the research is to conduct a survey interview directly with people that are involved and living within the locality where livestock are kept.

Methods:

The survey is completely voluntary, therefore participation is voluntary. You may choose not to participate or refuse to answer certain questions. However, you may be assured that your responses will remain completely confidential. All survey results will be release as summaries: no individual's answers will be identified: and your privacy will be protected to the maximum extent allowable by the community law.

Confidentiality:

The individual conducting the survey is a graduate student from the University of Alberta and the enumerators are from your local community. These people will make sure that information given and participants' specific comments are kept confidential. The name of the participant will not be written on the survey material instead a number will be assigned to each questionnaire. Materials used for data collection will only be accessible to the researcher and her supervisors. The data will be stored in the supervisor's office in a locked box which after the final report has been written and submitted; the survey material will be destroyed. No one will know what you say or directly identified you with any comment you made in any of our written reports or presentations resulting from this research.

Benefits:

By participating in this study, you will benefit from having the opportunity to provide direct input to this study in your local community and help policy makers to make good decisions. There will also be a token given to all that gave their initial consent to participate disregarding whether they completed the questionnaire during the interview or not.

Risks:

It is not expected that your participation in this study will cause any harm to you or any member of your household.

Withdrawal from the study:

Even after you have agreed to participate in this study you can decide that you do not want to complete the interview. You may withdraw from this study at any time. You may also request that your comments be removed from the study even after the survey has been completed. The researcher then cannot use what you said.

Use of the Information:

This study is not being paid for by any governmental institution. The researcher is a student at the University of Alberta. The information obtained from this study based on what everyone says will only be used to write a report. No individual responses will be included in the report. This survey questionnaire will be given to households identified and living in the metropolis and involved in one form of livestock keeping or another. The results will be used in Lola Lawrence's Master's thesis and publications from her thesis. The data collected may also be used for teaching undergraduate and graduate classes.

A4: Sample of Survey Questionnaire

University of Alberta Survey Questionnaire for Households to Characterize and Assess Human and Environmental Health Risks Associated with Urban and Periurban Livestock Keeping in Kaduna Metropolis, North Central Nigeria.

SECTION I: INTRODUCTION TO THE SURVEY AND LOCATION IDENTIFICATION

Thank you for agreeing to participate in this research! We're interested in your opinions and we'd like to ask for your help with this study. By participating in this survey you will be assisting a Nigerian student, Lola Lawrence who is studying at the University of Alberta in Canada. The study is for academic purposes only and will form part of the requirements for the award of a Master's degree in Agriculture and Resource Economics at the Department of Rural Economy. Please be informed that all your answers will remain private and anonymous, and you will not be associated personally with your answers. You are free to end this interview whenever you wish and not to answer any questions you do not want to.
The questionnaire survey should only take 60 minutes of your time and we would really appreciate your help.

Questionnaire Number: /_//_//_//_/ Date of Survey: /_//_/ /_//_/ /_//_/

I.D. # of the Enumerator: /_//_/ Start Time: / __// Finish Time: / __//

-Enumeration Area/District:

1- Location of household ☐ Urban ☐ Peri-urban

2- Enumeration area number: /_//_/

3- Household number in the study location: /_//_/

SECTION II: QUESTIONS ON LIVESTOCK KEEPING

Instruction for enumerators: The following questions should be directly addressed to the person identified as the household head/member that owns or is involved in keeping livestock in the household.

Q1. Do you keep any kind of livestock in your household?

☐ YES ☐ NO

If yes skip question 2, and go to question 3
If no, answer question 2 and go to the next section (iii)

Q2a. Why don't you keep livestock animals at all? Select all that apply

Financial resources
No space (area) and theft
Tradition (livestock keeping forbidden by authority)

- ○ No interest or lack of time and knowledge
- ○ Problems with neighbours
- ○ Rent ability of the space
- ○ Other reasons_____________

____

Q2b. Do you intend to keep livestock in the near future?

- ○ Definitely
- ○ Very Probably
- ○ Probably
- ○ Possibly
- ○ Probably Not
- ○ Very Probably Not

Q3a.
If you keep poultry birds (chickens, ducks, turkeys, pigeons etc), how many poultry birds do you have?

____

In your opinion what are your reasons for keeping these poultry birds? Circle all that apply

Personal/home consumption
Meat production only
For the eggs
I used to sell the birds when in need of money
Because I make profit from selling the birds
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbour keeps the same kind of birds
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons _________

____

Q3b.
If you keep sheep/rams, how many sheep/rams do you have?

____

In your opinion what are your reasons for keeping the sheep/rams? Circle all that apply

Production for personal/ home consumption
Meat production to be sold
I used to sell the sheep/ram when in need of money
Because I make profit from selling the sheep/rams
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbour keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons_____________

____

Q3c.
If you keep goats, how many goats do you have?

____

In your opinion what are your reasons for keeping the goats? Circle all that apply

Production for personal/ home consumption
Meat production to be sold
I used to sell the goats when in need of money
Because I make profit from selling the goats
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbor keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons_________

____

Q3d.
If you keep pigs, how many pigs do you have?

____

In your opinion what are your reasons for keeping pigs? Circle all that apply

Production for personal/ home consumption

Meat production to be sold
I used to sell the pigs when in need of money
Because I make profit from selling the pigs
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbor keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons_________

____

Q3e.
If you keep rabbits, how many rabbits do you have?

____

In your opinion what are your reasons for keeping the rabbits? Circle all that apply

Production for personal/ home consumption
Meat production to be sold
I used to sell the rabbit when in need of money
Because I make profit from selling the rabbits
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbour keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons _________

____

Q3f.
If you keep cattle, how many cattle do you have?

____

In your opinion what are your reasons for keeping the cattle? Circle all that apply

Production for personal/ home consumption
Meat production to be sold
Milk production to be sold
I used to sell the cattle when in need of money
Because I make profit from selling the cattle
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbor keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons _________

____

Q3g.
If you keep horses/donkey, how many horses/donkeys do you have? (Fill in Blank)

____

In your opinion what are your reasons for keeping horses/ donkeys? Circle all that apply

Production for personal/ home consumption
Meat production to be sold
I used to sell the horse/donkey when in need of money
Because I make profit from selling the horse/donkey
There is enough space to keep them
Because of the waste they produce
Not enough space
My neighbour keeps the same kind of livestock
Money required to start up is less
Money required to start-up is more
For cultural/religious reason
Their feed requirements
Other reasons ____________

____

Q4. From the following choices, we would like to know how important livestock keeping is to you, your household members and to your community at large:

INSTRUCTION: Please check one option only

a. Providing food to all persons within the household to get nutritionally and culturally acceptable diets at all times through local non-emergency sources.	Very important	Important	Moderately important
	Of little importance		Unimportant
b. Providing additional cash income for the family when livestock and their by-products are sold.	Very important	Important	Moderately important
	Of little importance		Unimportant
c. Providing means of support (subsistence) for the household during economic hardship	Very important	Important	Moderately important
	Of little importance		Unimportant
d. Meeting the household animal food protein needs	Very important	Important	Moderately important
	Of little importance		Unimportant
e. Providing employment opportunities to other household members in the neighborhood	Very important	Important	Moderately important
	Of little importance		Unimportant

Q5. What kind of housing do you provide for the livestock that you keep? (Fill in Blank)

____

Q6. Who owns the livestock kept in your household? (Fill in Blank)

____

Q7. Who in your household takes care of the livestock kept? (Fill in Blank)

____

Q8. Do you keep the livestock in your household for slaughtering to be sold in the local markets?
☐ YES ☐ NO

Q9. Do you keep the livestock in your household for slaughtering during festivals? ☐
YES ☐ NO

Q10. Do you keep the livestock in your household to slaughter for food?
☐ YES ☐ NO

Q11. What other uses do you derive from the livestock you keep? (Fill in Blank)

____

Q12. Where do you dispose of the by-products from slaughtered animals? (Fill in Blank)

____

Q13a. How do you store or dispose of the manure from your livestock wastes? (Fill in Blank)

____

Q13b. On a daily basis, what quantity of animal waste do you get from your livestock keeping activities? (Fill in Blank)

____

Q13c. Do you sell the waste or manure collected from your livestock?

☐Yes ☐No

Q13d. If yes, how do you measure and sell the waste collected? (Fill in Blank)

____

SECTION III: GENERAL RISK ATTITUDE QUESTIONS

Q14. How familiar are you with any health concerns identified to be associated with keeping livestock in cities?

○ Very familiar
○ Moderately familiar
○ Slightly familiar
○ Unfamiliar
○ Never considered it as a problem before this survey
○ I don't know

Q15. Keeping livestock in the cities or close to where people live is risky to humans and the environment?

☐ Agree ☐ Disagree ☐ Undecided

Q16. If you disagree, why do you think it is safe?

Q17. The following statements are identified as some of the health and environmental concerns associated with livestock keeping in cities.

INSTRUCTIONS: Please rate how strongly you agree or disagree with each of the statements by placing a check mark in the appropriate box.

a. Livestock roaming around the streets or roadsides cause no harm to people living around that area and to motorists.	Strongly Agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
b. Odours and smell from livestock keeping have no health effects on people living in the neighbourhood	Strongly Agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
c. Keeping livestock in cities could help in reduction and management of household wastes.	Strongly Agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
d. Keeping livestock provides easy and cheap access to more nutritious animal protein when needed	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
e. Consumption of animal food products from any source cause no harm	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
f. Dumping of livestock wastes anywhere does not affect people or the environment in anyway	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
g. People living with livestock do not have any health concerns	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
h. Keeping livestock in cities has no benefits	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
i. Livestock keeping causes a lot of noise in the neighborhood/ city	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree
j. I do not feel concerned about whether my neighbours keep livestock or not	Strongly agree	Somewhat agree	Somewhat Disagree	Strongly Disagree

Q18. We would like to have your opinion on how you will rate the extent or magnitude of these major potential outcomes identified from keeping livestock in your household/ Neighbourhood and in the city generally

INSTRUCTIONS: On a scale of 1-to-7, please check the risk rating that you believe each statement indicates on the dimension of risks associated with keeping livestock.

Please circle the appropriate number that you consider most accurate

a. **Perceived Risk:** Where "7" means the statement is extremely risky and "1" means not at all risky, how would you rate each statement

	Not Risky						Extremely Risky
Keeping livestock close to where people live causes no harm to humans	1	2	3	4	5	6	7
Livestock wastes/smell/odour/dust from poultry/pig housing are not a concern	1	2	3	4	5	6	7
Animal wastes can be stored and disposed anywhere	1	2	3	4	5	6	7
Eating food made from animal sources and animal by-products (such as milk, meat) is not harmful	1	2	3	4	5	6	7
Animal wastes can be applied to land and cause no harm to sources of drinking water	1	2	3	4	5	6	7
Touching animals that are sick, their beddings or inhaling air from poor livestock housing are not a concern	1	2	3	4	5	6	7

b. **Voluntary risk:** Where "7" means people do not know (i.e. are unaware of the consequences) that their personal livestock keeping and management practices can result in some health concerns and "1" means they do know (or are aware) of these health concerns.

	Voluntarily						Involuntarily
Keeping livestock close to where people live means no harm to humans	1	2	3	4	5	6	7
Livestock wastes/smell/odour/dust from poultry/pig housing are not a concern	1	2	3	4	5	6	7
Animal wastes can be stored and disposed anywhere	1	2	3	4	5	6	7
Eating food made from animal sources and animal	1	2	3	4	5	6	7

	Voluntarily						Involuntarily
by-products (such as milk, meat) is not harmful							
Animal wastes can be applied to land and cause no harm to sources of drinking water	1	2	3	4	5	6	7
Touching animals that are sick, their beddings or inhaling contaminated air from poor housing are not a concern	1	2	3	4	5	6	7

c. **Chronic-catastrophic**: Can any of these activities cause illness or kill people over a long period (1 = chronic risk) or can these activities results in illness that kills a large number of people on time (7 = catastrophic risk)?

	Chronic						Catastrophic
Keeping livestock close to where people live means no harm to humans	1	2	3	4	5	6	7
Livestock wastes/smell/odour/dust from poultry/pig housing are not a concern	1	2	3	4	5	6	7
Animal wastes can be stored and disposed anywhere	1	2	3	4	5	6	7
Eating food made from animal sources and animal by-products (such as milk, meat) is not harmful	1	2	3	4	5	6	7
Animal wastes can be applied to land and cause no harm to sources of drinking water	1	2	3	4	5	6	7
Touching animals that are sick, their beddings or inhaling contaminated air from poor housing are not a concern	1	2	3	4	5	6	7

d. **Severity of consequences:** When the risk from the health concern is realized in the form of illness, how likely is it that the consequence will be fatal (i.e. could result in death)?

	Certain not to be fatal						Certain to be fatal
Keeping livestock close to where people live means no harm to humans	1	2	3	4	5	6	7
Livestock wastes/smell/odour/dust from poultry/pig housing is	1	2	3	4	5	6	7
Animal wastes can be stored and disposed anywhere	1	2	3	4	5	6	7
Eating food made from animal sources and animal by-products (such as milk, meat) is not harmful	1	2	3	4	5	6	7
Animal wastes can be applied to land and cause no harm to sources of drinking water	1	2	3	4	5	6	7
Touching animals that are sick, their beddings or inhaling contaminated air from poor housing are not a concern	1	2	3	4	5	6	7

e. **Control over risk:** Based on your level of knowledge and experience could you control any health risk that could lead to death as result of keeping livestock or living close to where livestock are kept?

	Controllable						Uncontrollable
Keeping livestock close to where people live means no harm to humans	1	2	3	4	5	6	7
Livestock wastes/smell/odour/dust from poultry/pig housing are not a concern	1	2	3	4	5	6	7
Animal wastes can be stored and disposed anywhere	1	2	3	4	5	6	7
Eating food made from animal sources and animal by-products (such as milk, meat) is not harmful	1	2	3	4	5	6	7

Animal wastes can be applied to land and cause no harm to sources of drinking water	1	2	3	4	5	6	7
Touching animals that are sick, their beddings or inhaling contaminated air from poor housing are not a concern	1	2	3	4	5	6	7

Q19. We would like to have your opinion on the following questions about factors affecting risk perception in regards to knowledge and experience you have in keeping livestock.

Please circle the appropriate number that you consider accurate.

a. **Knowledge**

	Not Known precisely						**Known precisely**
How much do you know about the risks associated with keeping livestock?	1	2	3	4	5	6	7
To what extent are the risks associated with livestock keeping known precisely by those that keep or live close to the livestock?	1	2	3	4	5	6	7
To what extent are the risks associated with livestock keeping known precisely to science?	1	2	3	4	5	6	7

b. **Experience**

	No Experience						**Very Great Experience**
How experienced are you in handling some of the health concerns associated with keeping livestock?	1	2	3	4	5	6	7

	Tiny Impact						**Huge Impact**
How has this experience impacted or affected your life in dealing with these issues?	1	2	3	4	5	6	7

	Very Negative						**Very Positive**
Do you consider your experience to have a positive or negative influence with the idea of keeping livestock or living close to where livestock are kept?	1	2	3	4	5	6	7

Q20. We would like to have your opinion about potential benefits that might result from keeping livestock. Please check the benefit rating that you believe keeping livestock may bring to your household members.

Potential benefits	**Overall potential benefit rating**
Additional income/cash for the household members	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Animal manure sale	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Making jobs available for people living in the neighbourhood	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Provision of sufficient food in quantity and quality for all members of the household	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Cultural and social benefits	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Reducing and managing household wastes	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure
Providing means of support (subsistence) for the household during economic hardship	○High benefit potential ○Moderate benefit potential ○Slight benefit potential ○Almost no benefit potential ○Don't know/Unsure

Q21. In your own view, how would you compare the relationship between risks and benefits associated with keeping livestock in the cities or in your household?

○ Risks probably **significantly** outweigh benefits
○ Risks probably **moderately** outweigh benefits
○ Risks probably **slightly** outweigh benefits
○ Risk probably **roughly** equivalent to benefits
○ Benefits probably **slightly** outweigh risks
○ Benefits probably **moderately** outweigh risks
○ Benefits probably **significantly** outweigh risks
○ Don't know/Unsure

Q22. Are you willing to pay anything to reduce any of the identified health risks associated with keeping livestock in your neighborhood?

☐ Yes ☐ don't know ☐ No

INSTRUCTION: If the respondent does not keep livestock skip to question 29

SECTION IV: CONTINGENT VALUATION QUESTIONS

In this part of the interview, we would like to measure the value that you put on your livestock keeping activity. In order to do this, we will put in two hypothetical situations and we want you to think of both the positive and negative aspects of keeping livestock to yourself, your household and to other households within your neighbourhood. We would want you to consider these situations seriously and think of what you would really do in these instances. We also remind you that your answers are completely confidential and remain anonymous. Also there are no wrong or right responses.

Q23. Suppose you are presently not paying for basic environmental services in your area such as garbage pickup services, wastewater treatment or disposal of livestock waste due to your livestock keeping activities. If you then keep **X #** of livestock or generate **Y kg** of livestock waste and the value of manure (waste) produced from the animal is **Z** Naira per kg. Now suppose that the city/municipal authority would charge a weekly fee to all livestock keeping households for each 50kg waste produced from their households, and that you personally would need to pay this fee to keep your livestock in the neighbourhood, or you would be asked to forfeit keeping the livestock.

Note that the environmental services we are considering here are not real but hypothetical public goods and we are not promising that they will be provided by the city authority. But the health and environmental concerns associated with keeping livestock still exist now.

BIDDING GAME (USING 10, 20, 30, 40 or 50 Naira/amount of waste generated in kg per # of livestock kept). Use each amount until the respondent declines the amount suggested starting with the highest amount.

If the local government or municipal authority decides to charge a fee of _____Naira/amount of waste generated, would you be willing to pay this amount or would you decide to sell/forfeit all the livestock kept?

(IF THE ANSWER IS A POSITIVE AMOUNT, GO TO Q25)
(IF THE ANSWER IS "0", "DON'T KNOW" OR "REFUSAL", GO TO Q24)

Q24. You answered "0" amount, don't know or refusal, why and what is the most you would pay for? (Fill in Blank) ____

Q25. Now suppose that the problems of garbage pickup, wastewater contamination and manure disposal are resolved in the city or in your commnunity by providing these basic environmental services in order to reduce both human and environmental health risks associated with livestock keeping activities in your neighbourhood. In this case, raising the bidding amount at an increment of 10's

If the local government or municipal authority decides to charge a fee of ____Naira/amount of waste generated, would you be willing to pay this amount or would you decide to sell/forfeit all the livestock kept?

(IF THE ANSWER IS A POSITIVE AMOUNT, GO TO Q27)
(IF THE ANSWER IS "0", "DON'T KNOW" OR "REFUSAL", GO TO Q26)

Q26. You answered "0" amount, don't know or refusal, why and what is the most you would pay for? ________________________________

Q27. If you keep livestock in your household and the local/municipal authority asks you to pay a fee to obtain a yearly permit for keeping animals, are you willing-to-pay for the permit to enjoy the same benefits you currently get from keeping the livestock?

☐ Yes ☐ No ☐ Don't Know

Q28. If yes, up to what percent of your present income that comes from keeping livestock in your household are you willing-to-pay?

☐ 1 percent ☐ 2 percent ☐ 5 percent ☐ any percent
☐ a fixed percent charged/household
☐ a variable percent charged/number of livestock
☐ a variable percent charged per size of livestock

Q29. If at all in your opinion there are risks associated with livestock keeping, how do you think these should be reduced? (Mark all that apply)

☐ Charge only those keeping livestock
☐ disallow keeping of livestock in the cities
☐ Proper management of livestock
☐ discourage keeping of animals that have potential health threats
☐ Provision of veterinary/extension services
☐ Provide good waste management services
☐ Other options (mention them)
☐ don't know

SECTION V: SOCIO-ECONOMIC AND DEMOGRAPHIC INFORMATION

The following questions are designed to tell us a little about you. This information will only be used to report comparisons among groups of people interviewed. Your identity will not be linked to your responses in anyway.

Q30. Gender of Respondent:
(Respondents are not to be asked this question)
☐ Male ☐ Female

Q31. What age group would you put yourself on your last birthday?

☐ Under 15 years
☐ 16 to 24 years
☐ 25 to 34 years
☐ 35 to 44 years
☐ 45 to 54 years
☐ 55 to 64 years
☐ Over 65 years

Q32. How many people live in your household including yourself? (Fill in Blank)

____

Q33. How many children do you have in your household?

☐ No children ☐ One child
☐ Two children ☐ Three children
☐ Four children ☐ five children
☐ Six or more children

Q34. How many children living in your household fall into the following age group?

(i) Under Five years_________

(ii) 5 to11years__ ___________

(iii) 12 to 17years____________

Q35. What is your marital status?

☐ never married ☐married ☐ divorced ☐ separated
☐ widowed ☐ widower

Q36. What is the highest level of education you finished? (Mark one box only)

☐ No formal education
☐ Primary education (grade school)
☐ Secondary education (junior high)
☐ Senior high
☐ Trade or technical school
☐ College diploma/certificate
☐ Koranic instruction
☐ University degree
☐ Post graduate university degree (e.g., PGD, MSc or Ph.D.)

Q37. Which of the following options best describes your employment status? (Mark one box below)

☐ public officer
☐ self-employed/trader
☐ working full- or part-time
☐ retired officer
☐ full- or part-time student
☐ not in the wage labour force
☐ Farmer
☐ others

Q38. For study classification purposes, what percentage of your household income do you spend on animal food products? (Mark one box below)

☐ Less than 10 % ☐ 10% to 20% ☐ 21% to ☐ More than 50%
30% ☐ 31% to 40% ☐ 41% to 50%

Q39. What is the source of drinking water in your household? (Mark one box below)

☐ well ☐ borehole

☐ river ☐stream

☐public tap ☐others

Q40. Is the house or apartment building in which you live:
☐ Owned by you or someone in the household
☐ Rented for cash rent
☐ Occupied without payment of cash rent

Q41. How many years have you lived in your present house or community? (Fill in the blank)

____

Q42. How often do you go to the store/market to get the following animal food products?

Product	**Frequency of purchase**		
Milk	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Cheese	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Beef	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Chicken	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Pork	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Goat meat	☐Everyday	☐Once a week	☐Twice a week
	☐ Once every 2 weeks	☐ Once in a month	☐ Never
Mutton	☐Everyday	☐Once a week	☐Twice a week
(Sheep)	☐ Once every 2 weeks	☐ Once in a month	☐ Never

Other comments: ______________________________

Once again, we thank you for participating in this survey. Your time and effort is much appreciated.